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ANIMAL LIFE

(Prepared in accordance with the Revised
S. S. L. C. Syllabus)

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PREFACE

This little book is intended to help boys and girls to study and understand some of the commonest forms of Animal Life. Each lesson has a definite idea behind it and through all of them runs a common purpose. Animals are adapted to their environmental conditions and there is action and reaction between the animal and its environment. It is this aspect of life that is sought to be emphasised throughout the book. It is therefore necessary to remember that the lessons in the book are not mere collections of facts. A good teacher can easily vary the lessons to suit local requirements. His own enthusiasm and personal touch will go along to fill many an obvious gap. Study of animals is the study of *living things* and if this is kept steadily in view the purpose of this book will be fully served.

THE AUTHORS

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SYLLABUS

(1) *Movements in animals, their variety and importance.*—Fins of fishes; adhesive limbs of lizards; gliding of snake; swimming paddles of turtle; wings of birds; wings of bats; perching birds; legs of quadrupeds; limbs of cat, cow and horse with reference to their habits; flying butterfly; jumping locust; burrowing mole or cricket; clinging louse; slow creeping snail; burrowing earthworm.

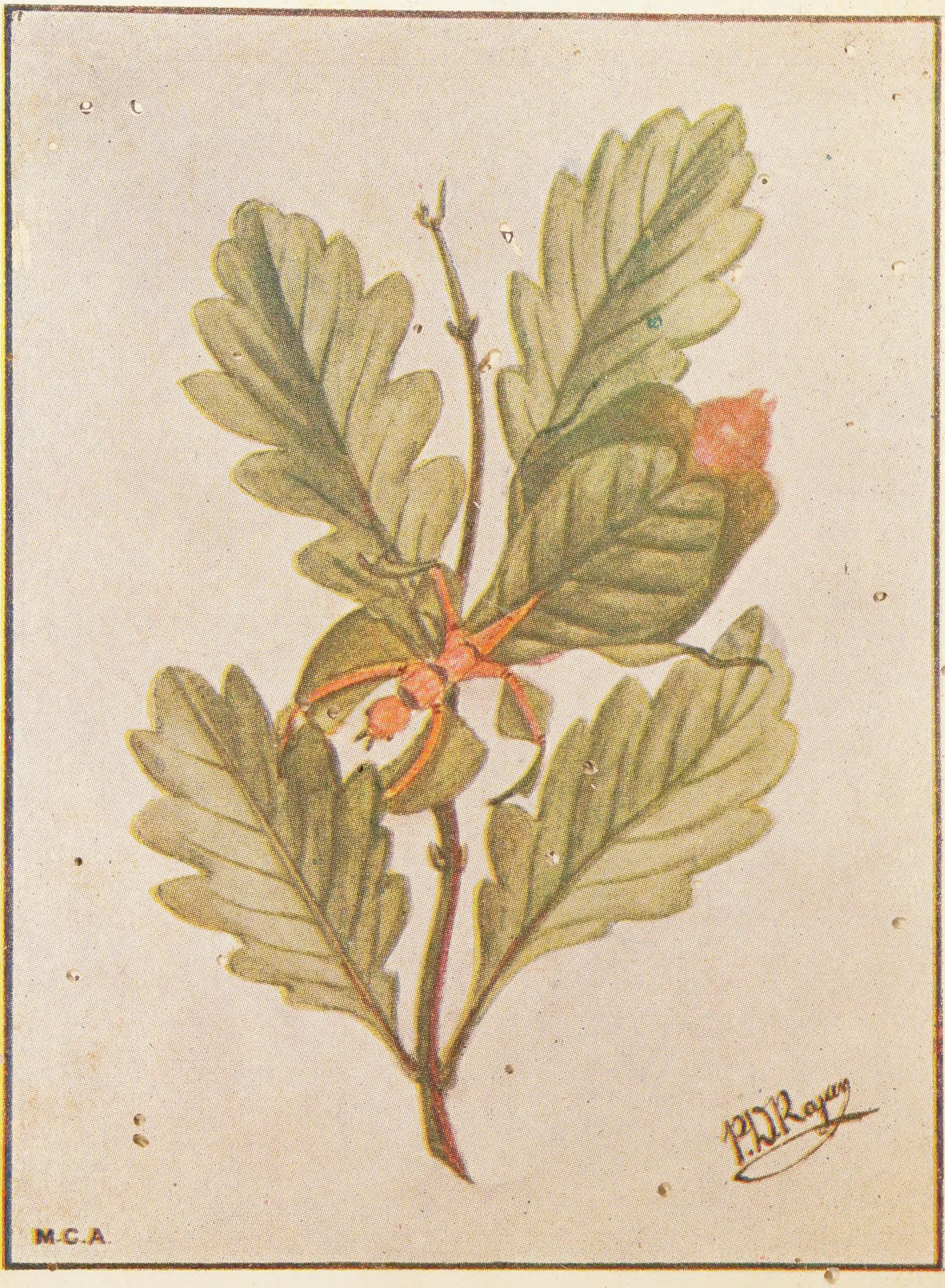
(2) *Food and feeding habits.*—Jawless earthworm; blood-sucking leech; leaf-eating caterpillar and grasshopper; honey sucking butterfly; punching snail; chewing crab; toothed vertebrates; feeding in frog, fish, snake, a carnivorous bird, cud-chewing cow, non-cud-chewing horse, carnivorous cat, gnawing squirrel; modifications of beaks in birds and teeth in mammals to suit carnivorous and herbivorous animals.

(3) *Breathing in animals.*—Gill breathing, fishes and crab; lung breathing in higher animals.

(4) *Special coverings*, such as spines of porcupines and shells of tortoises and turtles. *Colouration*, for concealment or for aggression, colour changes, mimicry; horns; poison apparatus in scorpions, centipedes and snakes; irritating hairs in caterpillars.

(5) *Life histories of animals.*—Sex difference in birds; oviparous and viviparous embryo and its food in the two cases; care of the eggs and young ones in birds; care of young ones in mammals; life history of frog; butterfly and mosquito, their characters during the several stages.

(6) *Animal societies.*—Ants and bees; members living in societies having a common cause; descipline among members.



LEAF INSECT *illustrating protective colouration.*

ANIMAL LIFE

CHAPTER I.

INTRODUCTION.

We are all interested in animals. Some of you perhaps have pets at home. In the garden and the field, in the pond and in the river you must have come across a number of nice and pretty animals. The butterflies and the grasshoppers of the garden are beautiful to look at. In the tanks you must have seen fish playing about. Lizards are often seen on the walls of our houses and in the corners small spiders build their webs.

Do you know how these animals live, what they eat, how they build their nests, how they protect themselves from heat and cold and from their enemies which would eat them? All these *animals move about.* Some creep, some run, others fly in the air and many others swim.

You feel hungry after work. You want to run home for your food. In the same way *all animals require food.* They must all search for their food and get it by their efforts. Food therefore is very necessary for all of us and for the creatures around us. Without food we shall all die. Unless we eat we cannot be strong. It is the same with animals.

But everybody's food is not the same. Some animals have no teeth. They swallow their food. Others crush their food well before they swallow it. Others still, like the butterfly, can take only liquid food. When once the food enters the stomach it is digested and made part of the body and the animal becomes strong.

When we go about our work we all breathe. If we stop breathing, we feel uncomfortable. We feel suffocated. When a boy runs we hear him breathing loud. His chest rises and falls rapidly. He is taking in air through his nose into his body. This is breathing. In the same way, *all animals must breathe.* They must all take air into their bodies. Different animals do this in different ways. Aquatic animals take oxygen that is dissolved in water. Land animals take in air directly. We see that breathing or Respiration, as it is called, is necessary for life. When you eat and play well, all of you will grow into bigger and stronger boys. Animals also are small to begin with. Later, they grow and become bigger. So, there is *growth in all animals.*

Many animals die every day. Many are killed and eaten. Some die of old age. Yet others die of accidents. *But most of them leave their children behind.* Some animals lay eggs; others bring forth young ones. They grow up like their parents. Some day they also die leaving their children behind. *It is the characteristic of animals to feed, breathe, grow and die leaving progeny.*

VERTEBRATES and INVERTEBRATES. There are several animals in this world. Many like the earthworm, leech, crab, centipede, grasshopper and snail have no back bone. These belong to the group of animals called the *Invertebrates.* Others like the fish, frog, lizard, bird and the rabbit have a backbone. Such animals are known as *Vertebrates.*

CHAPTER II.

FOOD, MUNCHING AND CHEWING.

Food is very important for all of us. The kind of food differs. If you go into the garden and look amongst the leaves you will very probably come across one or two caterpillars. If you watch them carefully you will see that they are slowly creeping on the surface of the leaves and gradually eating the leaf away. They have two tiny jaws placed at the sides of the mouth. These jaws cut little bits of the leaf and crush them before eating. The caterpillar is a very voracious animal. It eats a large amount of leaf substance. Often in the garden you will notice the edges of the leaves cut. It is the caterpillar that has done

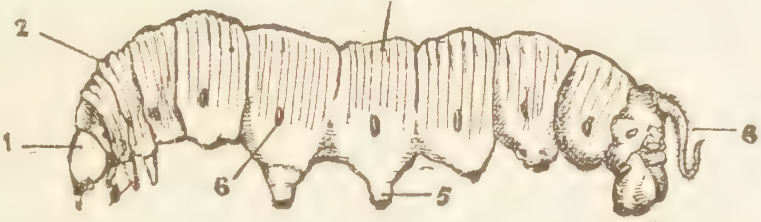


Fig. 1. A caterpillar. 1. head; 2, region carrying three pairs of jointed legs; 3, third region bearing blunt legs (pseudopods); 4, anal spur; 5, a pseudopod; 6, a breathing aperture (stigmata).

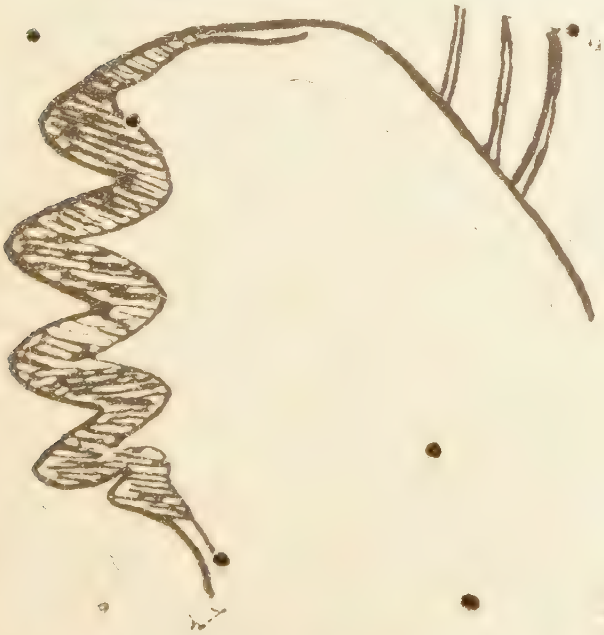


Fig. 2. A jaw of a caterpillar (magnified)..

this. A jaw is shown in the picture. There are a few teeth on it. They are well suited to cut tender leaves and crush them. If you observe the animal, you will notice several legs on the under side of it. Behind the head there are three pairs of ordinary legs and still behind there are five or six pairs of stout legs with blunt ends. These enable the animal to adhere firmly and crawl on smooth leaf surfaces with ease, while feeding.

Like the caterpillar, the grasshopper also lives on leaves. But one finds it more often among grass. It has also powerful jaws. Often several of these grasshoppers can be seen together in one place. They are able to destroy large numbers of leaves. You must have heard of the Locust. It is a kind of grasshopper. Locusts live in large numbers and fly over long distances. When hungry, they settle on a field and very quickly the leaves are eaten away and the field becomes bare. In this way they do great harm to our crops. In South India swarms of locusts are not common. In

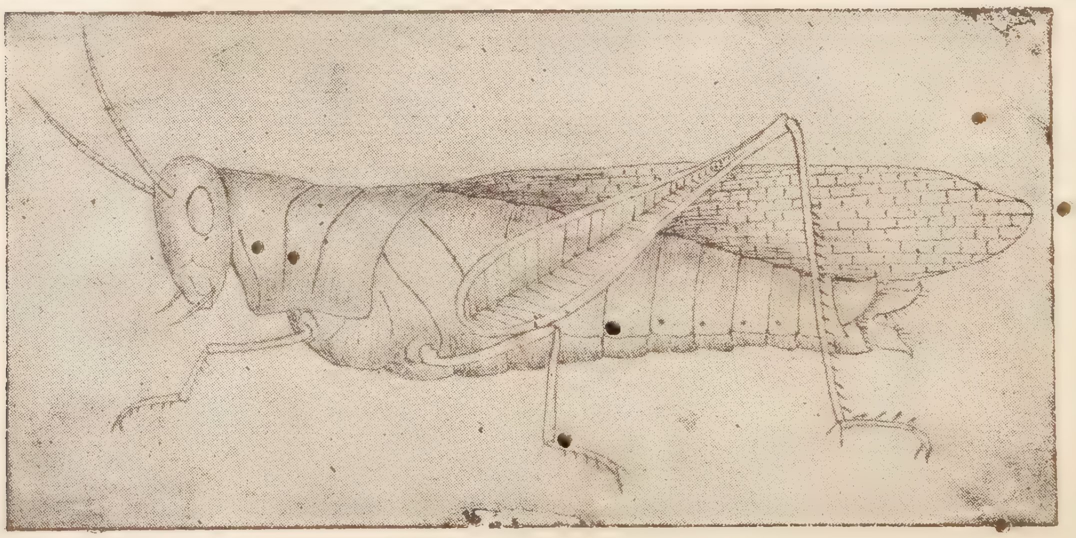


Fig. 3. A grasshopper.

North India, however, they come in large swarms, quite suddenly, and destroy food crops. These insects are still more common and troublesome in Arabia, Palestine and Egypt. Sometimes famines result from the destruction caused by these insects.

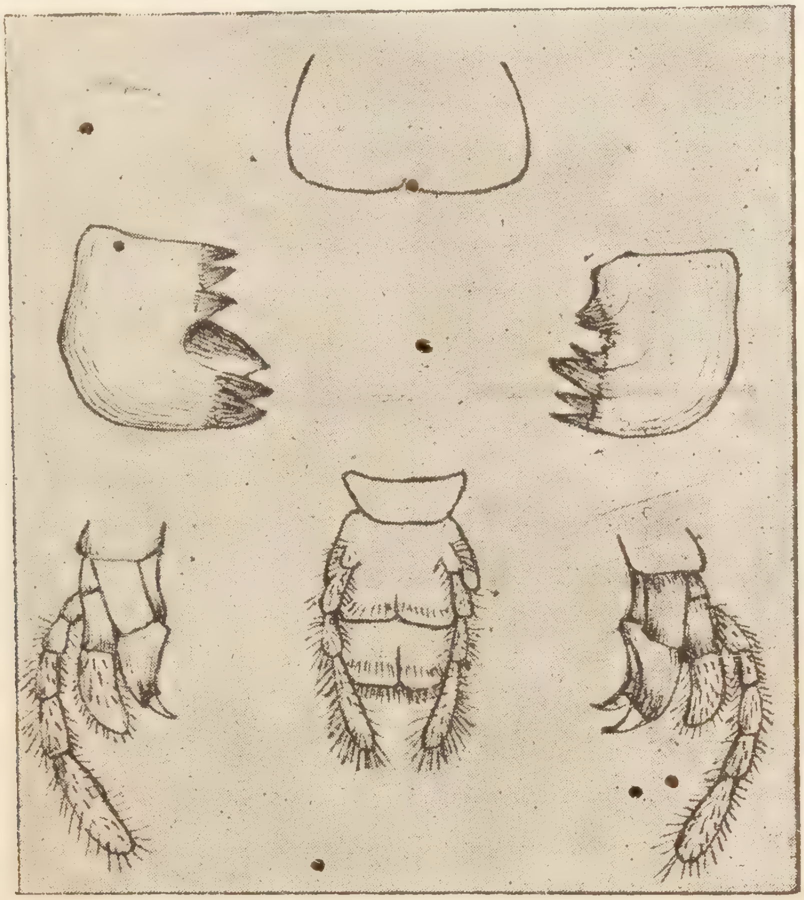


Fig. 4. Mouth parts of a grasshopper. Note the two hard jaws with teeth.

Snails also feed mostly on leaves. They are found on cold mornings on plants, crawling very slowly. If you watch a snail on a glass plate you will see it pushing out now and then the inside of its mouth. You will then see a small glistening structure. It is, like sand paper, very rough and the leaf is caught between the lips and bit by bit the leaf is rasped away and eaten. The snail has a soft flat foot. It is sticky.

It can therefore easily crawl on smooth surfaces of leaves without falling off.

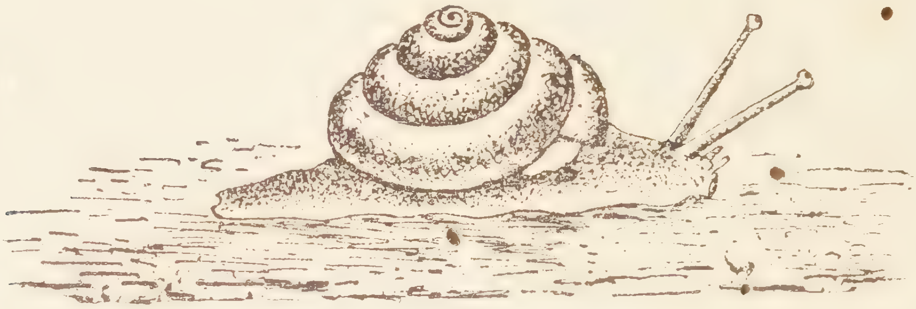


Fig. 5. A land snail creeping.

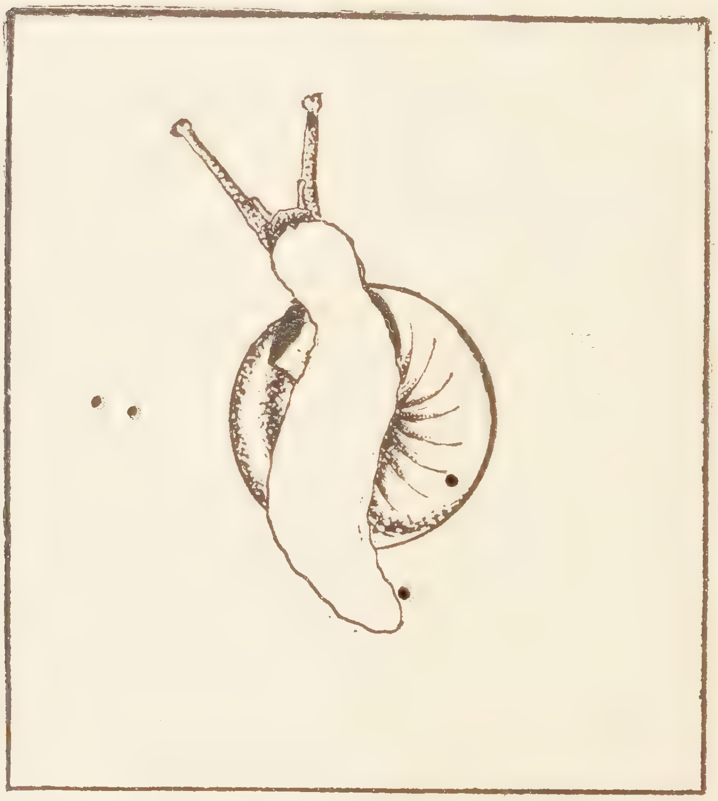


Fig. 6. A snail creeping on a glass plate.

We have now studied the feeding habits of three kinds of animals. All of them live amongst leaves or in grass. They must seek for their food in the place they live. The grasshopper hops from place to place and feeds on grass and on tender leaves. The caterpillar and the snail are found creeping on leaves of plants. All the three of them have mouth parts well suited to crush the leaves which form their food.

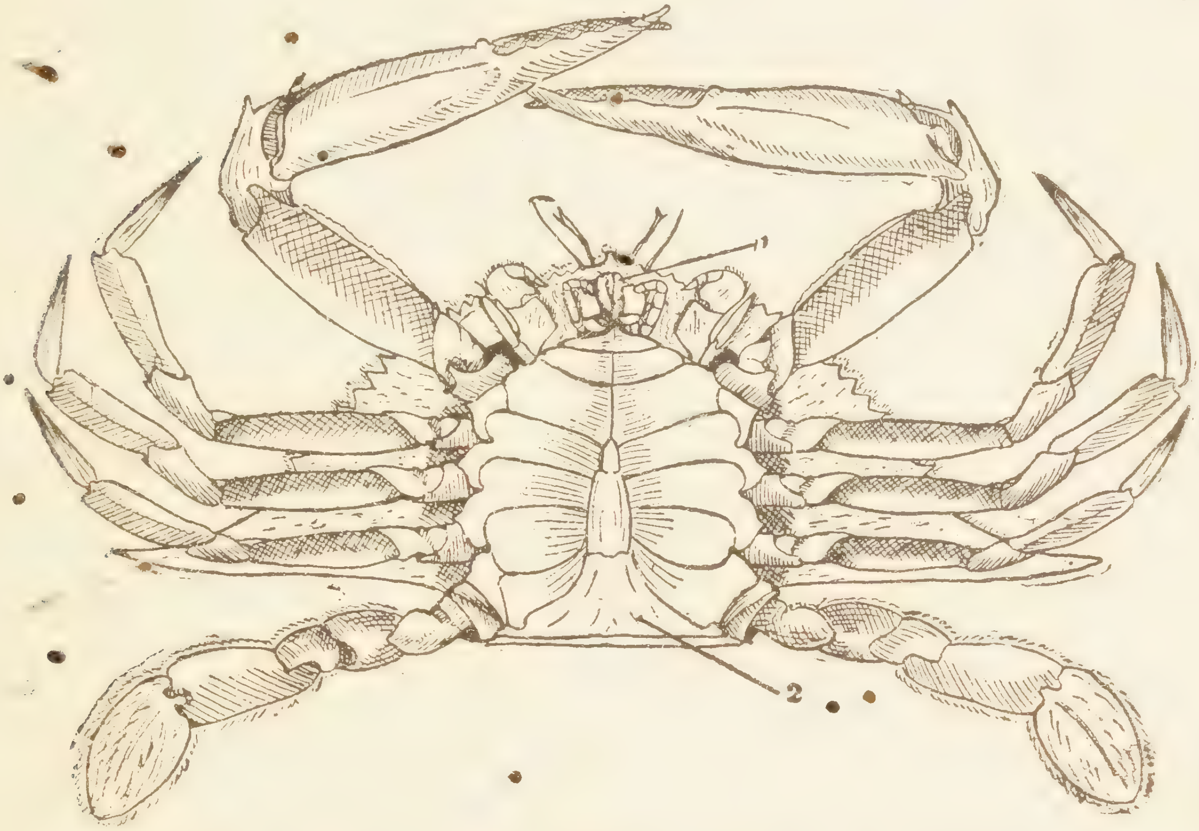


Fig. 7. Crab. Ventral side. 1, jaws; 2, abdomen.

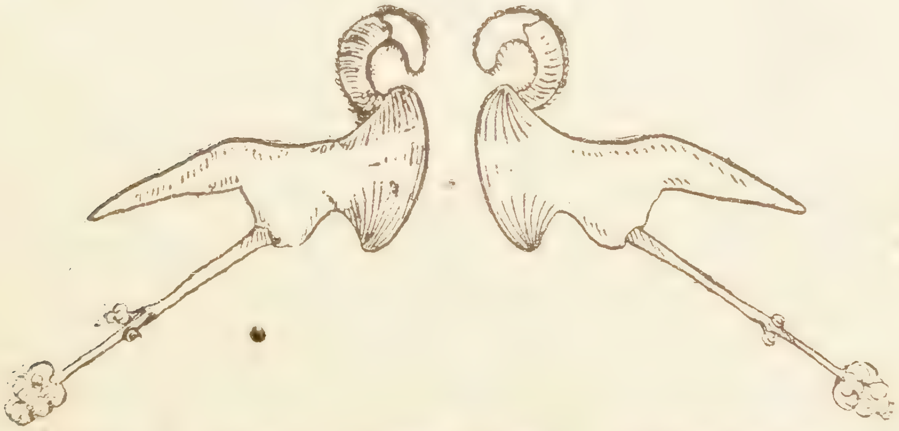


Fig. 8. Crab. Jaws of crab. (Magnified).

The crab also is a munching animal. But it does not live on land (there are some exceptions) but in holes and among rocks in water. It eats any kind of food that it can get hold of. Often it is a broken bit of weed. At other times it is a bit of dead flesh. Whatever the nature of the food, the crab takes hold of it and crushes it by its two powerful jaws, makes it into a soft mass, and then swallows it.

EXERCISE

Go to a garden early morning taking with you one or two empty cardboard boxes with a few holes bored at the top. Search for caterpillars, grasshoppers and snails. When you find them, observe how they move and feed. Note the plants on which they are found. Very probably they are their food plants. Carry home a few of the caterpillars with some of the leaves on which they are found in the cardboard boxes. Also take with you one or two snails. Place the boxes with caterpillars in them in a cool place, renew the food leaves daily and observe what happens. Place the snails on a plate with a small quantity of water and watch them crawl out. Make sketches of the animals you study.

CHAPTER III.

FOOD (*contd.*)—SUCKING ANIMALS.

Butterflies are beautiful pretty creatures. You can see them early morning when the garden is bright and green and the flowers are fully open. They flit from flower to flower. They fold their wings and rest a little while on each flower. What do they do? It is very difficult to observe what they do from a distance. They appear to sit quietly for a short time on one flower and then go away to another. If you approach them cautiously you may, if you are lucky, see the butterfly unroll from the under surface of its head what looks like a tube, which is thrust into the bottom of the flower. The

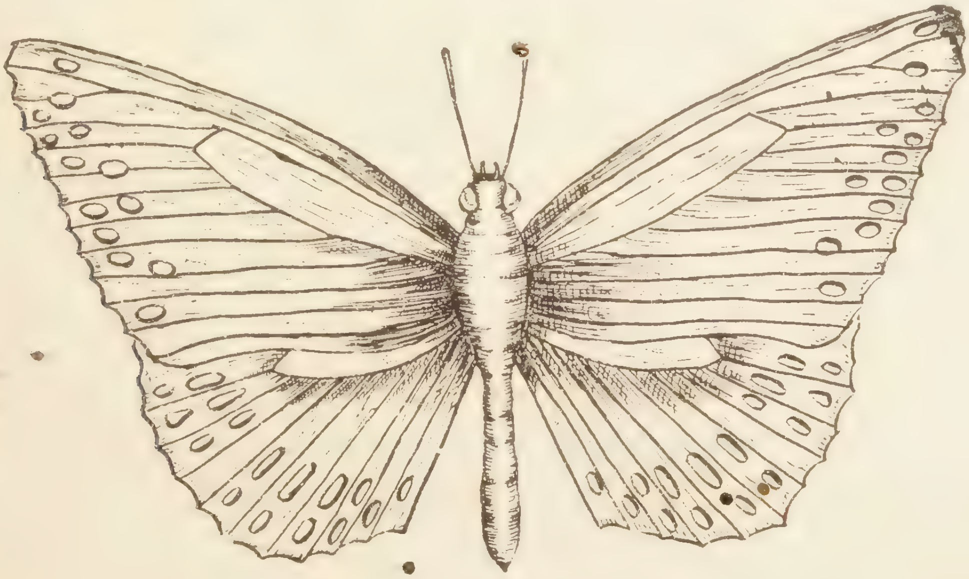


Fig. 9. A butterfly.

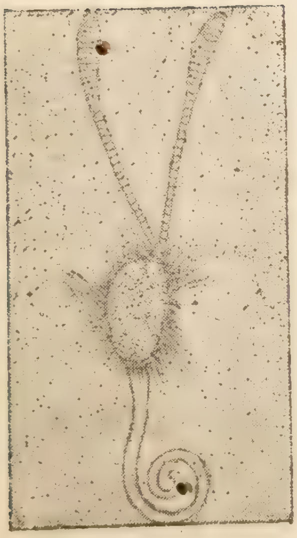


Fig. 10. Tongue of butterfly.

tube is rolled up again and the butterfly goes away. This tube is the tongue of the butterfly. It can be rolled and unrolled. The butterfly has no jaws like those of the caterpillar or the grasshopper. It cannot therefore bite or take any solid food. But with its long tongue it can suck any liquid food. That is exactly what it does. Many flowers produce nectar at their bases. If you take the white flower of Adathoda, remove the green base and suck at the bottom of the flower, as many of you have no doubt done, you will get a sweet liquid into your mouth. It is the nectar. The butterfly is fond of this. It can live only on this juice. If you prevent a butterfly from visiting flowers, it will grow thin and finally die. Its food is in the flowers and that is why it goes to the flowers. Its long tongue is very useful because it can be sent to the base of the flower and the nectar can be sucked up. It is a wonderful arrangement. Jaws are of no use to the butterfly. The moth also feeds like the butterfly.

You know what a leech is. One is shown in the picture. It lives in tanks and streams. It swims by wriggling movements. In front there is a sucker. At the tail end there is a much bigger sucker. If you place a leech on a glass plate, it will attach itself to the smooth surface of the glass by its two suckers. Even if you hold the glass plate upside down, the leech will hold on to the surface and move by looping movements like a caterpillar. The leech is a curious animal. Its habits are strange. For its food, it must have blood. To get this it attaches itself to the bodies of animals. Sometimes a frog is attacked, sometimes as when a man gets into water in which they live he is attacked, and it sticks to his foot. The leech has three jaws. With these it inflicts on the skin a bite. The appearance caused by the bite is like three short radiating lines from a centre. Each jaw is in the form of a cushion on which are several minute teeth. Once the wound is caused by the bite, the animal begins to suck the blood. The blood is stored in a number of small sacs in the front part of the food canal. When the leech is satisfied it lets go its hold on the skin. For several days afterwards the leech

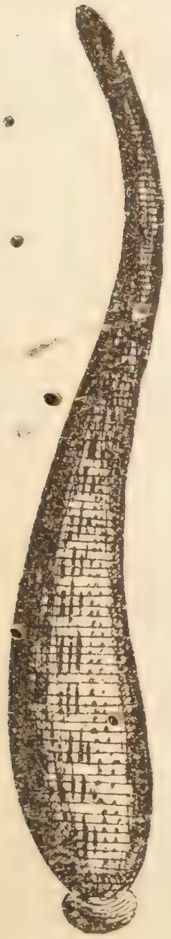


Fig. 11.

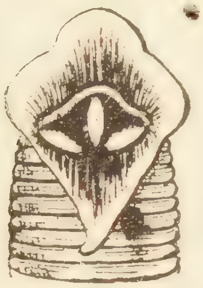


Fig. 12.

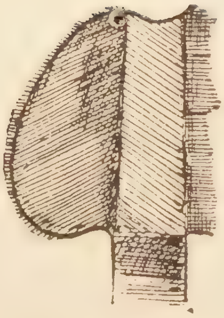


Fig. 13.

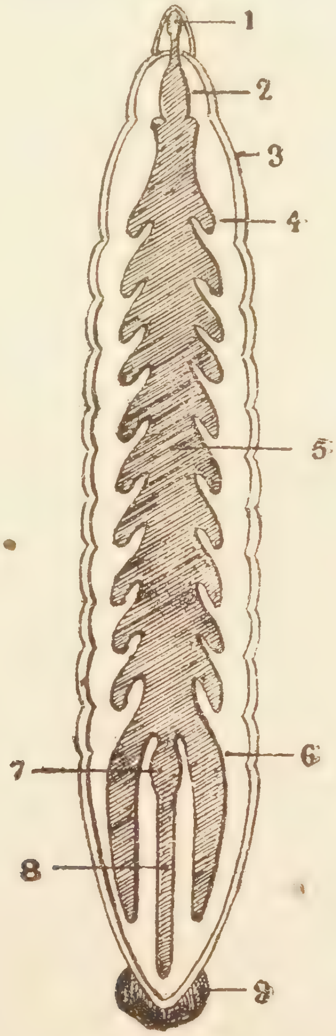


Fig. 14.

Fig. 11. The common Madras leech.

Fig. 12. The three jaws of the leech at the entrance to the mouth.

Fig. 13. A single jaw (magnified). Note the minute teeth.

Fig. 14. Alimentary canal of leech. 1, anterior sucker; 2, pharynx ; 3, body wall ; 4, 6, the first and the last pouch of crop 5 ; 7, stomach ; 8, intestine ; 9, posterior sucker.

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does not feed. It has taken enough and lives on the blood stored up in this manner.

Like the butterfly the leech can take only liquid food. In this case it is blood. The butterfly need not bite the flower to reach the sweet juice. Hence no jaws are necessary to the butterfly. The leech on the other hand must cut the skin first. That is why it has jaws. *The mouth parts of the butterfly and the leech are in accordance with their feeding habits.*

CHAPTER IV.

HOW THE FISH FEEDS.

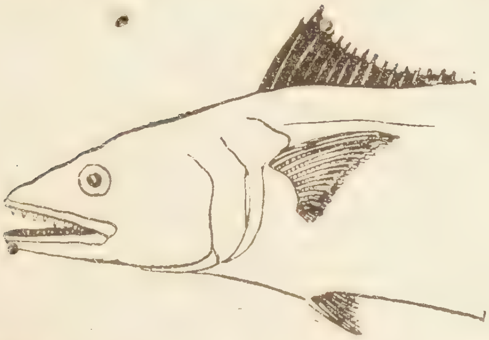

Fig. 15. Head of fish showing mouth with small teeth.

Vertebrates have a backbone. This gives them shape, strength and rigidity. It is in relation with the backbone that the forelimbs and the hind limbs are placed. Vertebrate animals have usually an upper and a lower jaw. The jaws carry teeth. In the fish there are several teeth in each jaw. They are all mostly similar, small and pointed. The picture of the mouth of a fish is shown here. Such teeth are good for catching something but not for crushing. In tanks, rivers and the sea, where the fish live, they swim with speed and when they see an animal suitable for food, they seize it and swallow it *without crushing*.

Though most fish have pointed teeth and can only swallow the food, there are others which live at the sea-bottom which possess plate like teeth. One such fish is shown in the picture. You can see that all the teeth are flat. They are placed edge to edge like the slabs on a pavement of the floor of a building. Both jaws possess similar teeth. Don't you think that the teeth are suited to crush things? When you want to crush anything, you place it between two flat stones. In the same way, the Ray fish crushes with its flat teeth snails and snail-like animals on which it is fond of feeding.

The two kinds of fishes which we have now considered show us that the teeth of animals are always

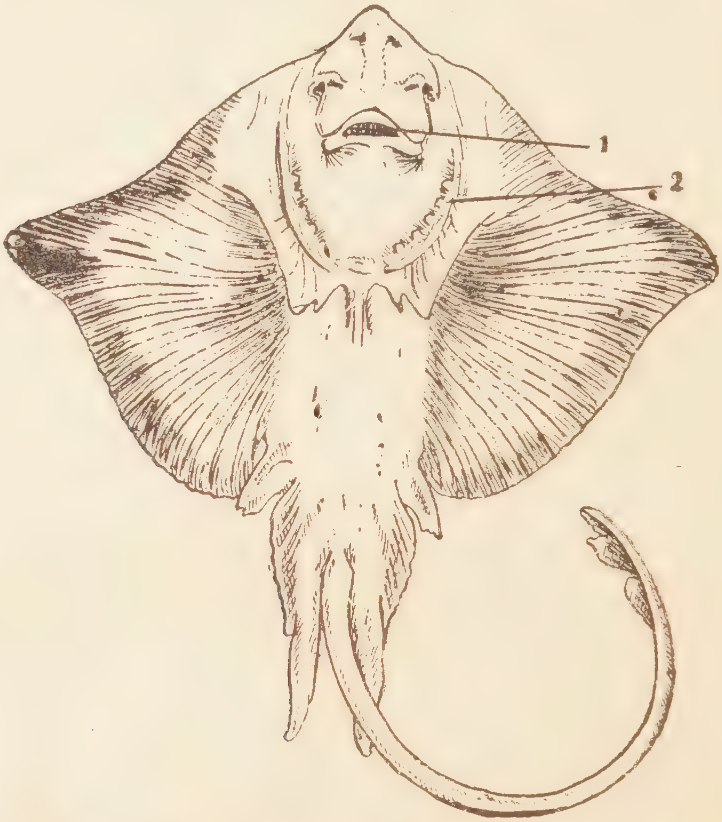

Fig. 16. Ray fish. 1, mouth with teeth; 2, gills lits.

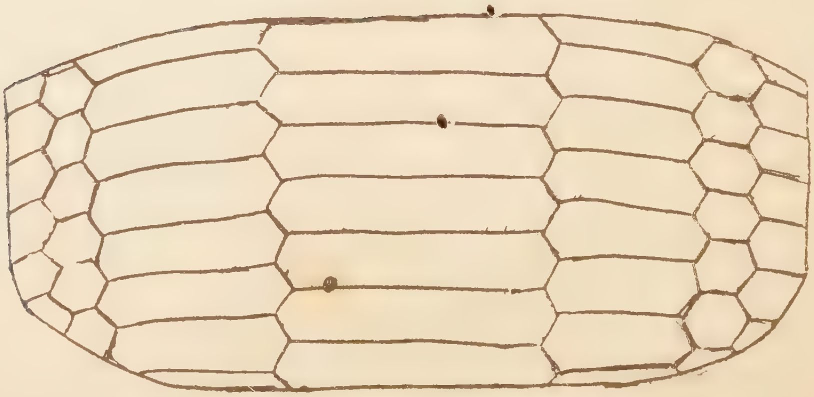

Fig. 17. Flat teeth of Ray fish.

suited to the nature of the food. In the first case, the food is composed mostly of worms, shrimps and other similar animals. These animals move with great rapidity. It is therefore necessary to catch them and swallow them up quickly. That is why most of the bony fishes are provided with sharp conical teeth.

Others, like the Rayfish, which are sluggish in their habits and live mostly at the bottom, feed mainly on slow moving snail-like animals with hard shells. The shell has to be broken. Is it not therefore necessary that the teeth should be flat and strong?

EXERCISE

Keep a few small fresh water fish in a fairly large suitable glass vessel. Place some fresh water weeds in it. Feed the fish on small bread crumbs or on grains of boiled rice. Observe that they swallow their food without munching. Visit the aquarium, if you happen, to go to Madras, and see the fish fed.

CHAPTER V.

HOOFS, CLAWS AND TEETH.

All of you have seen the cow feeding. They are fond of grass. They like to frequent grassy plains and banks of rivers for here they can get food which they like. They have huge bodies and they want a lot of food and they go to places where grass and leaves can be had in plenty. They graze the whole day long straying from one field to another. They feed quickly and fill their stomach. When they get home they have time to rest. If you watch them at rest, after a day in the fields, you will see them moving their lower jaw from side to side. They appear to be munching something. Do you know what they are doing? During daytime they swallowed large quantities of food. They had no time to munch well and make it soft. They swallowed

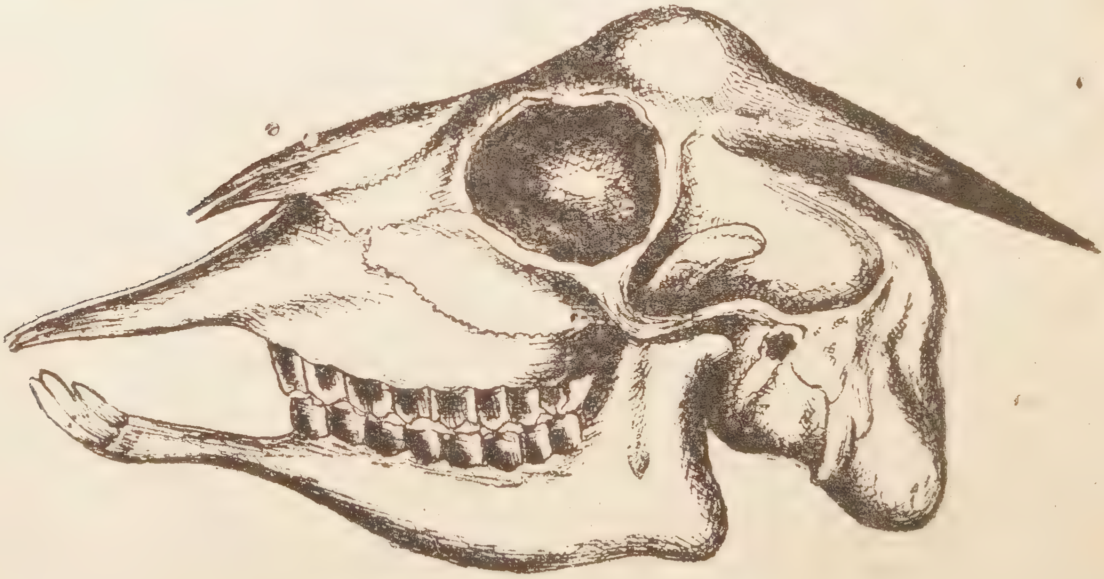

Fig. 18. Skull of goat. Note absence of teeth in front of upper jaw and the chisel-like teeth in the front of the lower jaw.

it quickly and kept it in a part of their capacious stomach. Reaching home, they lie down quietly and bring back this partially munched food into the mouth, mix it with the saliva of the mouth, crush it well and long, and then swallow it again. Look at the skull of a cow or a sheep. There are no teeth in the front part of the upper jaw. In the lower jaw, in front, there are four chisel like teeth on each side. At the back of the mouth there are several well developed teeth which are suited for crushing soft as well as hard grass. The front of the upper jaw has a hard plate only. When the animal feeds, the chisel like teeth of the lower jaw are pressed against the edge of the hard plate and the animal is able to cut off the grass and leaves easily. But when the food is again brought back to the mouth, the hind teeth are able to crush it well and make it soft.

How is the food sent again to the mouth? Here is a picture of the stomach of a sheep. It is not a simple bag. There is the food tube (gullet) in the throat leading into a big bag which is divided into four compartments. The inside of the first compartment is velvet like

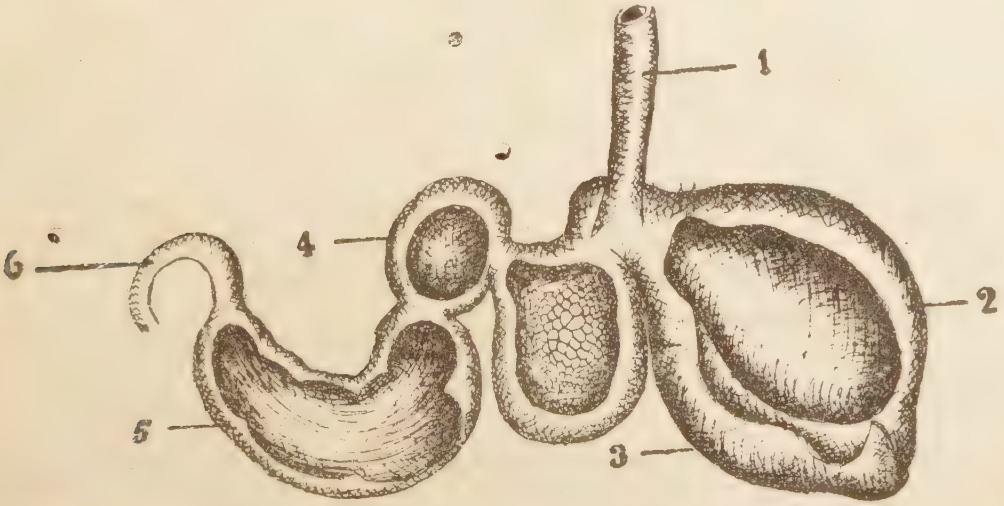

Fig. 19. Stomach of a ruminating animal. 1, gullet; 2, first chamber (Rumen); 3, second chamber (Reticulum); 4, third chamber (Psalterium); 5, fourth chamber (Abomasum); 6, duodenum.

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and that of the second netlike. The third has leaflike folds inside and the fourth is glandular. When the animal feeds quickly, the food is sent to the first compartment and when that becomes full into the second. Here it is well softened. Later on, when the cow is at home, the food from the first and second compartments is sent to the mouth. In a way the cow vomits its food little by little and chews it again. When it does this, you notice the cow moving its lower jaw from side to side. It is now said to *chew the cud.* It is also said to *Ruminate.* The sheep and the camel are also ruminating animals. When the food is thoroughly chewed it is sent to the third and the fourth compartments where it is strained and only food in fluid form is allowed to pass on.

Thus feeding in the cow is a laborious process. It wants a large quantity of food to strengthen its huge body. It must eat *quickly when it can* and chew it *at leisure.*

The horse does not chew the cud. If you look at the skull of a horse, you will see cutting teeth in the lower

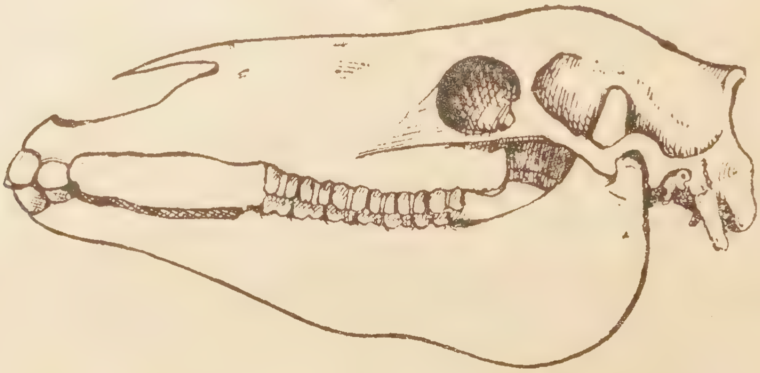
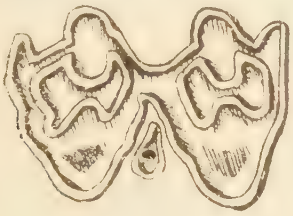


Fig. 20. Skull of horse. Note teeth in front of both jaws.

as well as in the upper jaw. The back teeth are also suited for crushing although they are different from those of the cow in appearance. The horse, when it eats, crushes the food well and then swallows it. Therefore, in the horse the stomach is not chambered and the food is not sent back to the mouth.



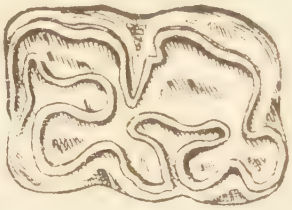


Fig.21. A crushing tooth of a cow. Fig.22. A crushing tooth of a horse

Now we shall see how the squirrel feeds. All of you know the animal. Some of you probably keep it as a pet. It is fond of living in trees, and now and then comes into our houses. Its body is covered with soft hair. It has large ears and a pair of pretty little eyes. The most beautiful part is the brush like tail. It is fond of carrying its tail over its back. It has a cheery voice. When frightened, it shouts out to its companions and jerks its tail. Probably it is trying to tell its friends that some danger threatens them. Often you see it sitting upright. It holds something in its

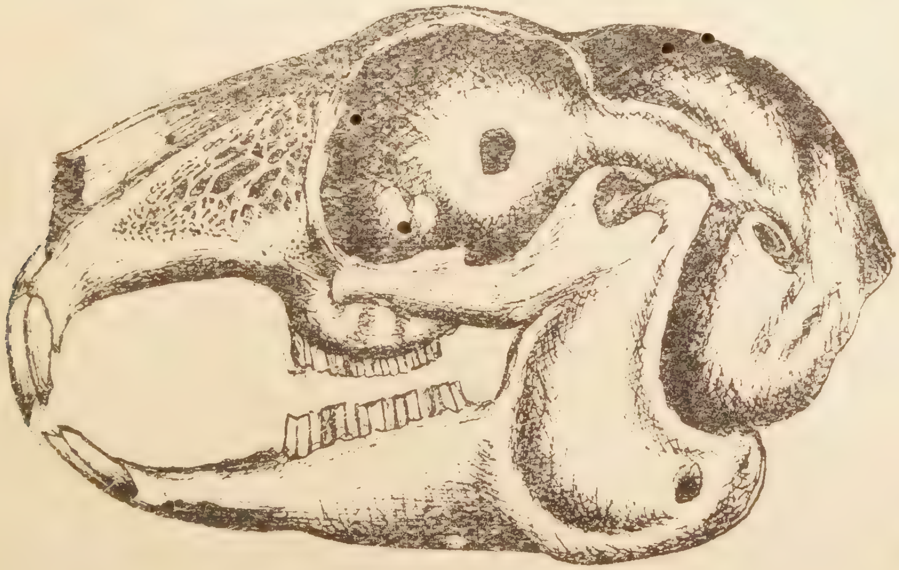


Fig. 23. Skull of rabbit.

hands. The cow and the horse cannot do this. But the squirrel can use its hands just as we can. It can take hold of a nut and crack it with its teeth. Squirrels are fond of nuts. They are always in search of them. Do you know how they break these nuts? Look at the skull of the squirrel. It is very small. The teeth in front are curved. There are two teeth in the front part of both the jaws. They are both curved, chisel like and strong. These enable the squirrel to crack the nuts. Having done so, it crushes the soft kernel of the nut by its back teeth and swallows it. Squirrels are fond of fruits also. They like plantains and mangoes and eat them with relish. They are delightful animals. They do not like flesh. Therefore like the horse and the cow they live upon vegetables. These are called HERBIVOROUS animals. The rabbit, though it is not arboreal, resembles the squirrel in regard to its food. The stomachs of herbivorous animals must be big because vegetable feeders take a large quanitity of food. In the picture the food canal of a rabbit is shown. There is a part of the canal called the caecum. This part is well developed in animals like the cow, horse, rat and the rabbit, which feed on vegetables. The food canal is also long. It must be so, for there must be room enough for all the food that they take.

Don't you want to know now something about an animal that does not take vegetable food but hich is fond of flesh? The cat is such an animal. It is never so happy as when it gets a mouse to eat, or a bit of flesh. It is a beast of prey. It has large eyes and ears, a body covered with fine soft fur, and a tail which gives you warning of what it is going to do. It has very sharp claws. When it is happy and rubs against your body gladly, the claws are withdrawn. When angry or when it wants to catch a mouse, the sharp claws are all well out, ready to tear anything that they might take hold of.

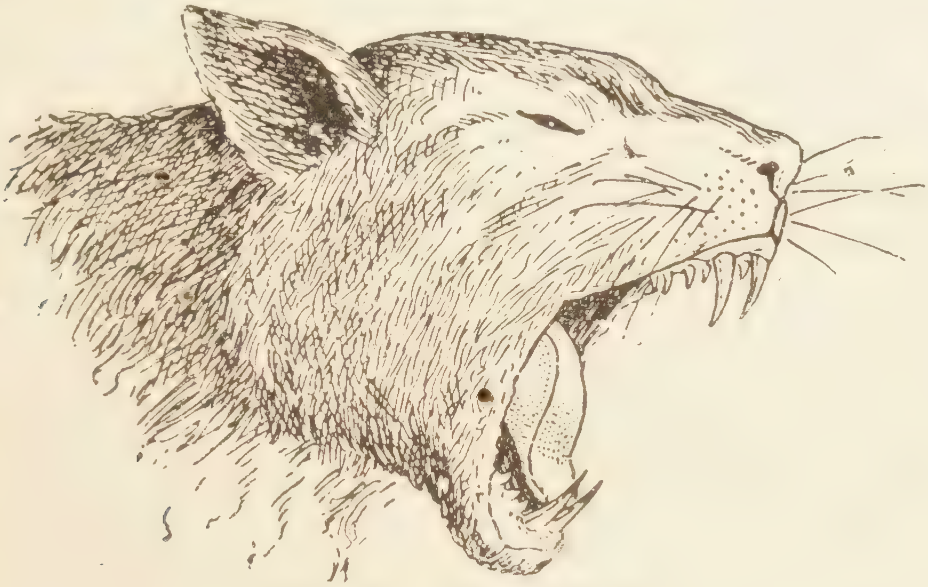


Fig. 24. Head of cat.

The cow and the horse have no such claws. They do not want them. They have not got to catch other animals for food. But the cat must do so and claws are necessary. Look at the skull of the cat. It is round almost like a ball. The front teeth are small and set in a row. These are the *Chisel teeth or Incisors.* Behind them you observe the long, sharp single tooth by means of which the mouse is caught. This is called the CANNINE TOOTH. It is intended to kill. All flesh eating animals have it and are called CARNIVOROUS animals. Behind the cannine tooth

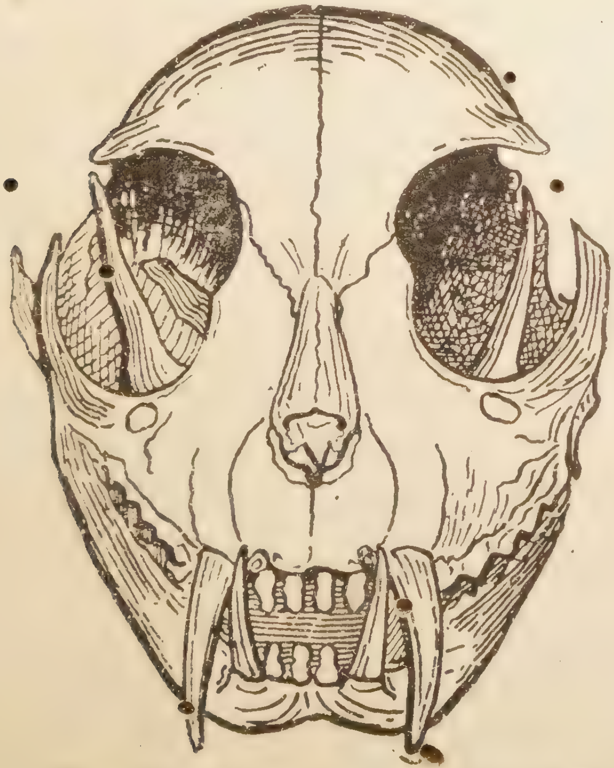


Fig. 25. Front view of skull of cat.

there are others which are different. In the cat these teeth are not suited for crushing. They are not flat. But they can cut and tear. The third back tooth in the upper and the fifth in the lower, work like the two blades of a pair of scissors. The cat, having killed the mouse, holds it firmly with the jaws, tears it to pieces by the back teeth and then swallows it. The tiger, the lion, and the dog are all carnivorous. They all eat flesh. They must kill their victims and tear them to pieces.

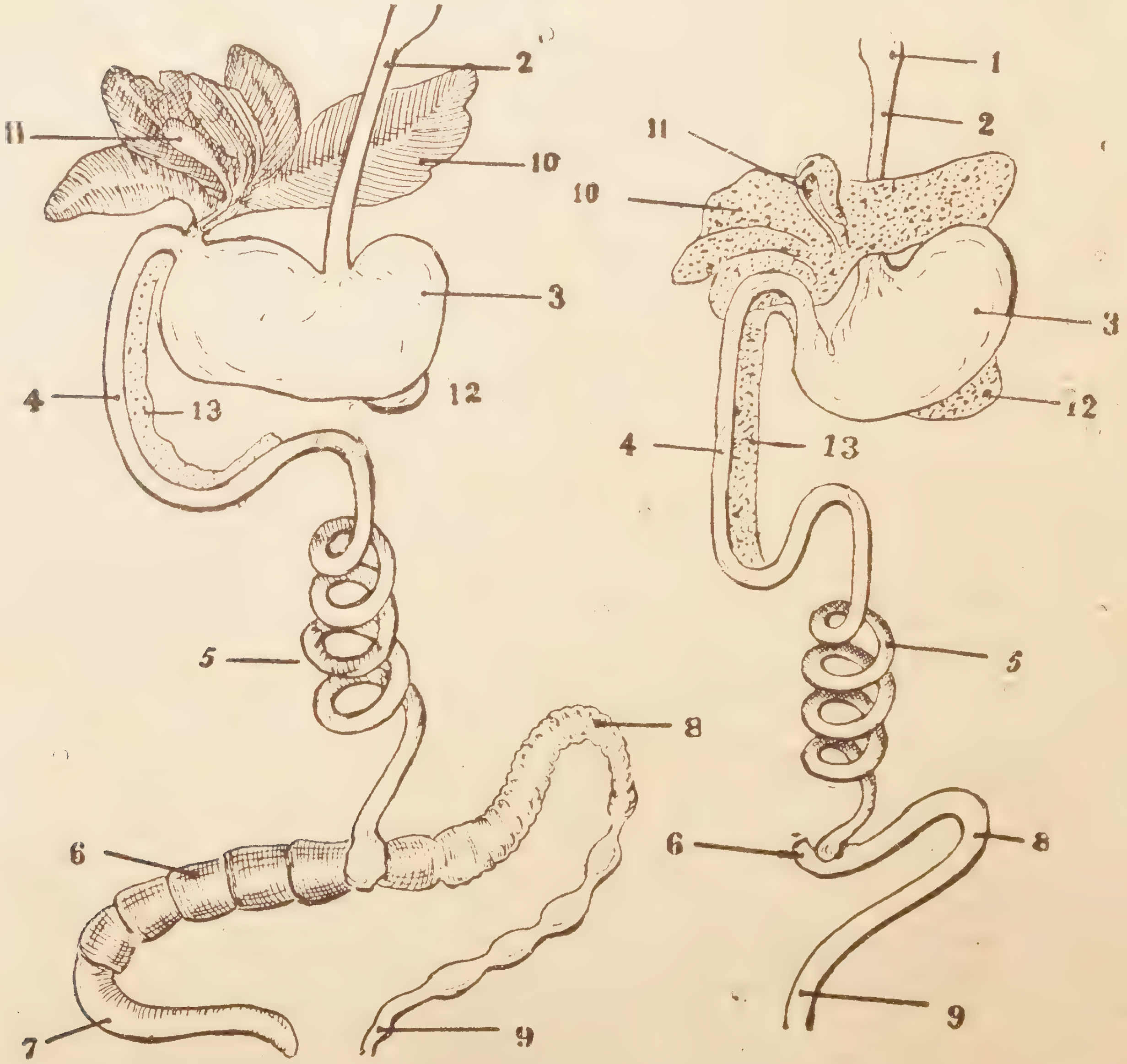


Fig. 26. Alimentary canal of the rabbit (left) and the cat (right.) 1, Pharynx; 2, gullet; 3, stomach; 4, duodenum; 5, intestine; 6, caecum; 7, Vermiform appendix; 8, colon; 9, rectum; 10, liver; 11, gallbladder; 13, pancreas.

Now you understand why they all have sharp claws and the cannine teeth.

Is there any difference in their food canal? Surely there must be. They have not to eat so much as the herbivorous animals. They eat flesh which is more nutritious than vegetable matter and therefore their food canal need not be as long as that of a vegetable feeder. The picture of the food canal of the cat is shown here. The cat is about the same size as the rabbit. But the food is different in the two cases, and therefore the food canal of the carnivorous animal is generally shorter than that of the herbivorous one. The caecum which is long in the vegetable eating animals is not so in the cat.

We have thus seen *how the claws, teeth and the stomach are suited for the food that is eaten.*

EXERCISE

Observe the cow and the horse while feeding. Note what the cow does when it lies down to rest after a day in the fields. Examine the side of the skull of a cow, a horse and a cat. Note the nature of the teeth in each case.

CHAPTER VI.

BEAKS AND FEET OF BIRDS.

In this lesson we shall learn how birds feed. We are acquainted with several kinds of birds and are familiar with the crow and the sparrow. We see them every day. There is the pigeon which many people keep in large numbers. The kite flies very gracefully in the sky. What do these birds feed on? Do they all take the same kind of food? The tiny little sparrow comes into the house and picks up small food grains. It goes into the field and eats grains of paddy. The sparrow often chases grasshoppers and swallows them. But food grains, like the paddy, is what it is fond of. The pigeon is fed on peas, mustard and other similar food. Have you ever seen a kite coming down and eating (food) grains? No. It does not like food grains. It is fond of mice.

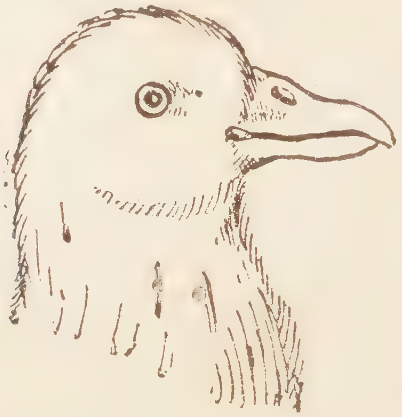


Fig. 27. Head of pigeon.

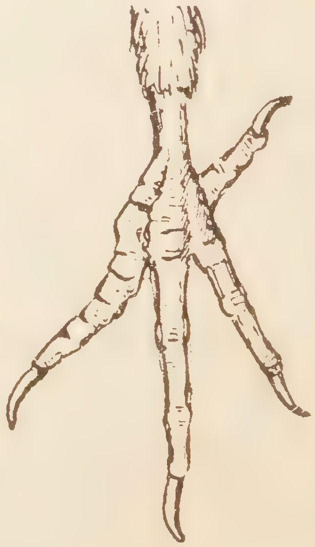


Fig. 28. Leg of pigeon.

Often it catches frogs. Kites are also fond of fish and flesh.

Thus we have here two kinds of birds, birds which like food grains, and other which like fish or flesh. Can we, by looking at a bird, say what it feeds on? Look at the pictures shown here. You see the beaks of a pigeon, a sparrow, a kite and a vulture. You see also the legs of the same birds. The beak of a pigeon and sparrow are nearly conical. Those of the kite and the vulture are not conical but strong and curved, and are not good for picking up grains. They are suited for tearing up the bodies of animals. The feet of all birds have four toes, three of which are turned forwards and one backwards, and they end in claws. When a bird sits on a branch, the four toes automatically clutch the branch firmly. It is very much like what we do when we take hold of a stick. We catch the stick with four

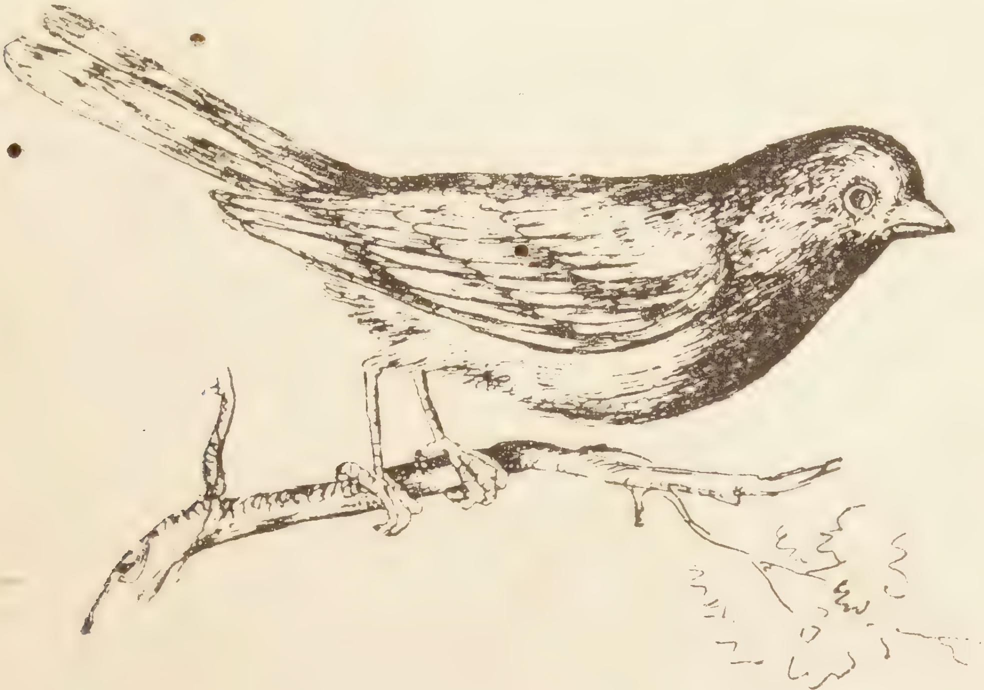


Fig. 29. House sparrow.

fingers in front and the thumb behind. Birds do the same.

The cock and the hen in the backyards of our houses scratch the soil to find out grains or worms to feed on. The grain eating birds have not to scratch in the ground but only to pick up the grains. Their claws are not strong and curved. The lower part of the legs are not covered with feathers. They are naked and slender. It is so in the sparrow and the pigeon, because of similar habits. It is not so in the flesh eating birds.

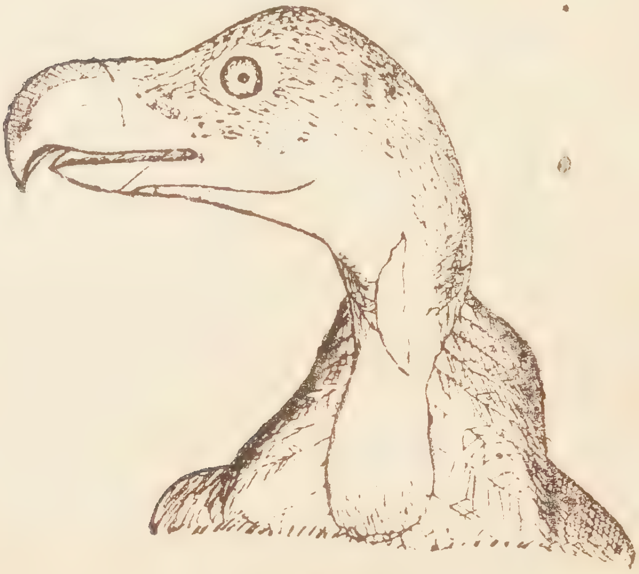


Fig. 30. Head of vulture.

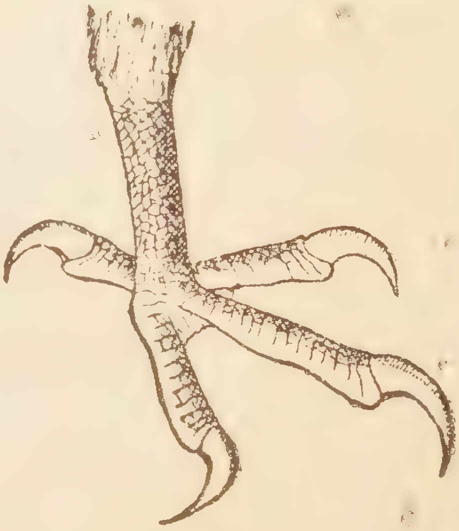


Fig. 31. Foot of vulture.

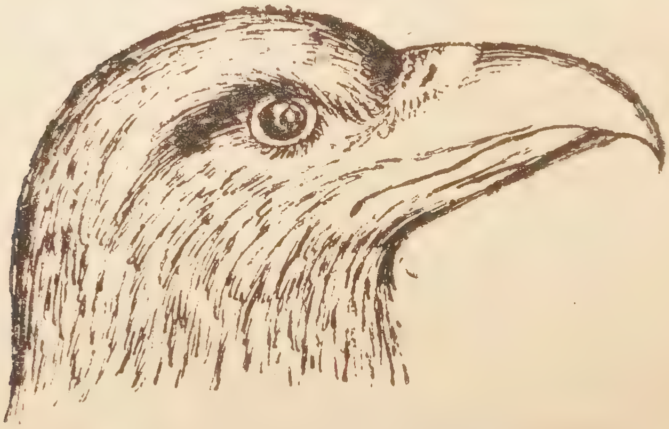


Fig. 32. Head of the carnivorous kite.

They have to hunt for their food. Very often they have to fight with their prey, before they can kill them. It is, therefore, necessary to have strong,

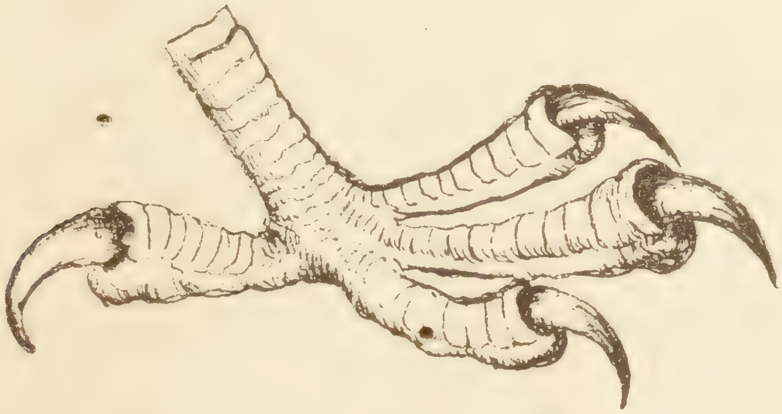


Fig. 33. Foot of the carnivorous kite.

well curved beaks so that they may tear open the bodies of their enemies and victims. The legs and toes are also suited for this work. Many of you have seen how a kite carries away a chicken in its strong claws. It swoops down from the air quite suddenly and seizes the helpless chick in its strong claws. To do this the legs and the claws must be strong. Often the kite takes hold of a bloodsucker which tries to bite the leg of the kite. But it can do no harm as the legs are protected by hard scales. We saw, how in the grain eating birds the beak is conical, the legs slender and provided with ordinary claws. In the flesh eating birds, on the other hand, there are powerful curved claws and the legs are often protected by hard scales or feathers. Don't you think that this is a beautiful adaptation in accordance with the nature of the food that they take?

We saw in the previous lessons that the stomach also is adapted to the nature of the food. We shall see whether this is the case in the birds as well. The pigeon, as you know, now, picks up food grains and swallows them. It has no teeth. In fact, no bird has teeth. The grains go into a large sac where they are stored up and well softened. Then only are the grains sent to the next part of the alimentary canal. This second part is a muscular chamber. Here the grains are well ground up by the working of the muscles. This softened food is sent further down into the alimentary canal and is digested and assimilated.

In those birds which do not eat grains, the first chamber of the alimentary canal or the *crop*, as it is called, is not well developed as also the grinding mill. Ony those organs that are useful are well developed. Useless organs tend to disappear.

There are other birds which take a different kind of food. When the Rangoon creeper is in flower you can often see a cheery little bird with glossy wings and a needle like beak flitting among the flowers. This is the *Sun bird.* Like the butterfly it is very fond of honey. The butterfly has a tubelike tongue to suck the nectar. The sun bird has a very long and tubular beak the end of which is inserted into the throat of the flower and the nectar is thus drawn up into the mouth. The butterfly and the sun bird are different kinds of animals. But they want the same kind of food. Therefore they have a long tubular tongue in the one case and a long and slender beak in the other, to reach the nectar in the flowers.

Many of you have walked to the paddy fields of your village when they are bright and green and there is water in them. Often the water collects in small ponds and ditches by the side of the paddy fields. When you go along, almost without your noticing it, a white bird rises up from the edge of the water, flaps its wings and flies off. This is the *Paddy bird*. When it sits, it is not noticed. It is all brown. If it were white you would have noticed it. But the bird does not want to be noticed, and so it is brown like the surroundings. It has a long neck, long legs and a long beak. It can wade in water without wetting its feathers. When it rests, the long and slender legs look like reeds growing out of the water. The fish in the water, not noticing the bird come near and are snapped up by the long beak of the waiting bird. The paddy bird is adapted by its long beak and long slender legs to wade in water and snap up fish. The duck is also adapted by its flat beak and webbed feet for life in water.

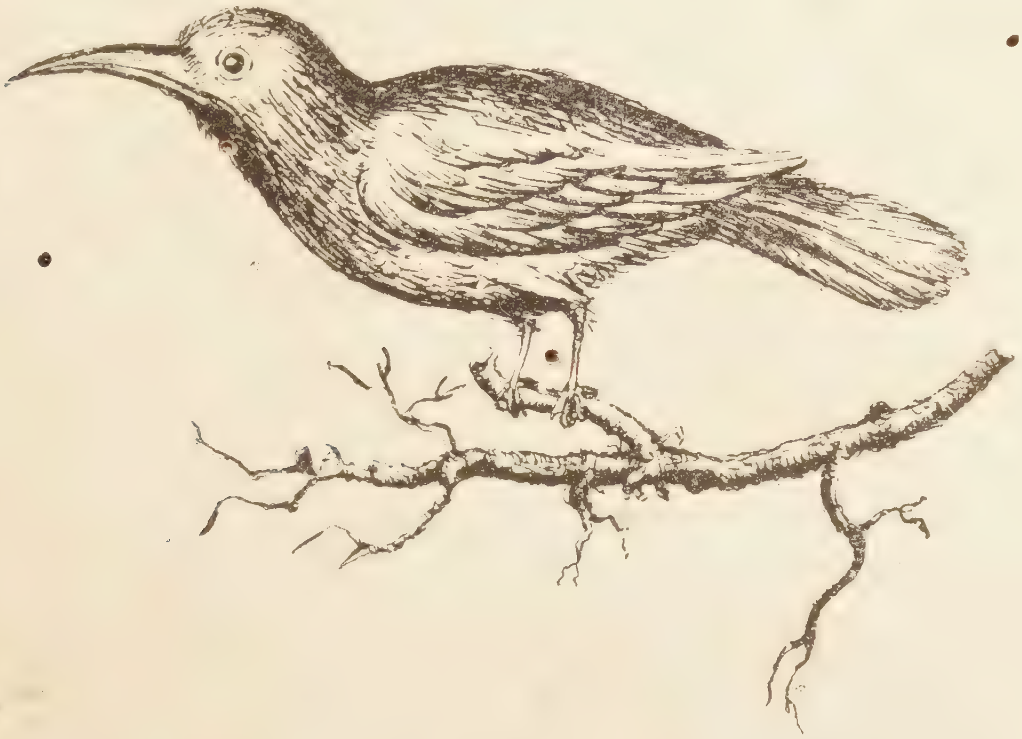


Fig. 34. Sunbird. Note long pointed beak.

The kingfishers are wonderful birds. There are three common birds of this kind in South India. All of them are fond of fish and haunt tanks and rivers. One of these birds is fairly large and has a red beak, glossy blue wings and a white chest. It waits patiently on a stump of a tree gazing intently on the waters below. When it espies a fish coming up to the surface, it swoops down, head foremost, and catching the fish comes up and flies to the nearest tree stump, knocks the fish against it and swallows it, head end first.

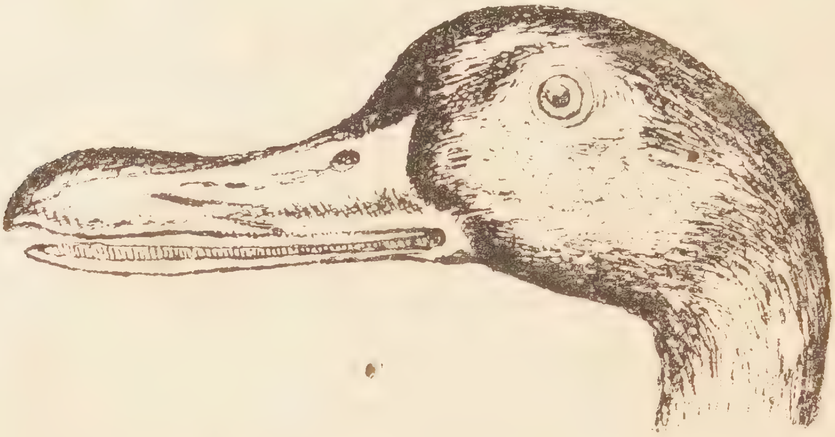


Fig. 35. Head of the aquatic duck.

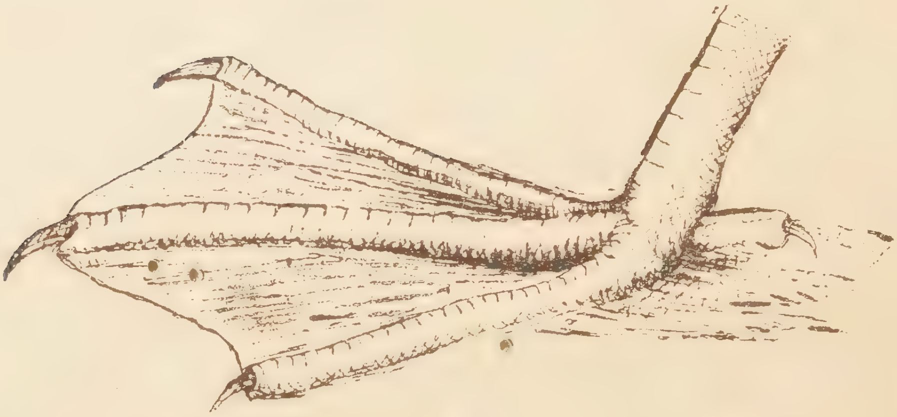


Fig. 36. Webbed foot of the aquatic duck.

Another kingfisher is black and white in colour. It hovers about ten feet above the water, and when a fish is sighted, the bird darts after it and seizes it in its beak. The third and the smallest of the three kingfishers is similar in its habits to the white breasted kingfisher.

Kingfishers lay their eggs in holes in banks of rivers and canals.

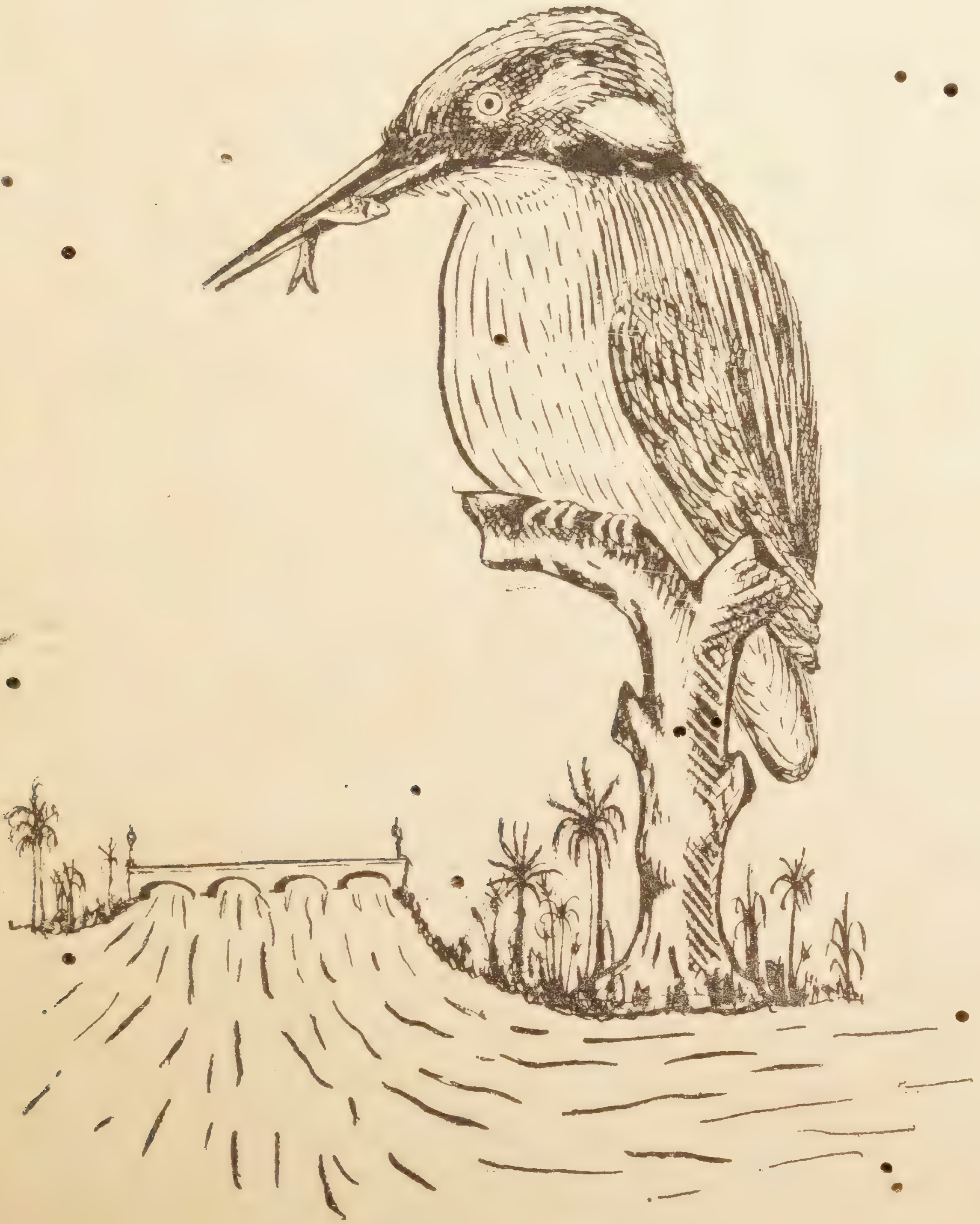


Fig. 37. Kingfisher.

Many birds feed mainly on insects. They are known as INSECTIVOROUS birds. The myna, the woodpecker, the hoopoe and the wagtail are all insectivorous. The woodpecker is a very curious bird. It feeds on the

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insects and insect larvae found under the bark of trees. It has a long beak. Two toes are directed forwards and two backwards. The tail feathers are short and stiff and can be planted against the trunk of the tree and act as a support to the bird. It runs up a tree tapping the bark here and there with its long beak to find out if the bark is hollow underneath. Then it selects a suitable spot in the bark, bores a hole and inserting its long tongue tipped with spines, pulls out the insects from under the bark. *All birds are thus well adapted by the structure of the beak and toes, to the nature of their food.*

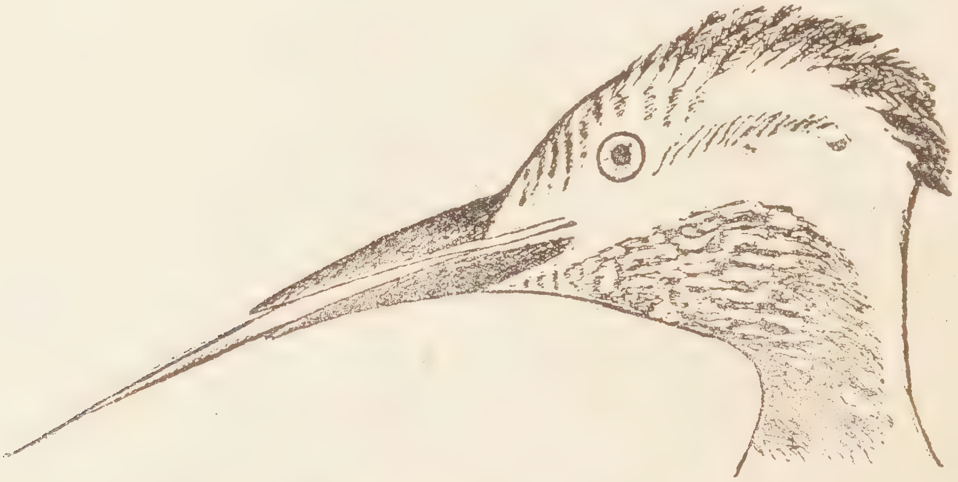

Fig. 38. Head of woodpecker.

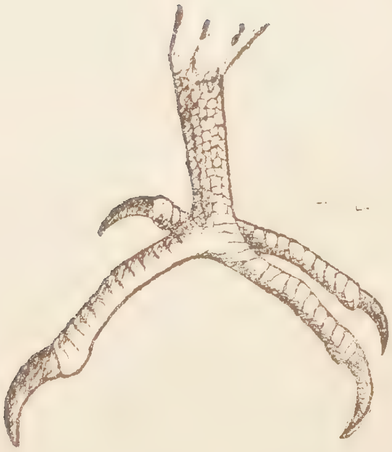

Fig. 39. Foot of woodpecker.

EXERCISE

Go out into the fields as often as you can and observe the birds in their natural surroundings. Note very carefully the beak and feet in each case and at the same time the food they eat. Keep a record of your observations.

CHAPTER VII.

SNAKES.

We do not like snakes. Still they teach us many things. Fishes swim, birds fly, and horses run. Each by its bodily structure is suited to the life it leads. The snake crawls. We shall study how it is able to do this, what food it takes, and how it gets it.

All of you have seen snakes. They are caught and shown in the street by snake charmers. You see in the picture some of the common snakes, such as the krait, the cobra, the Russell's viper, and the tree snake. They all have long bodies. They are animals with a back bone. The body is covered with scales and they creep rapidly on the ground. They have no limbs. Why? Suppose these long bodied animals had a pair of limbs in front and another pair behind, like those of the lizard. Can they move quickly? Will these limbs be able to support *the entire length* of the body above the ground? Will it be an advantage? No. Legs will be a hindrance to animals with *very long* bodies. Therefore they have disappeared. Snakes can crawl with the entire body on the ground instead of dragging themselves by means of two pairs of legs too weak to support the body. The scales of the under surface of most of the snakes are broad. The hind edges of these scales are pushed against the ground and the animal wriggles along. Some snakes can crawl very rapidly. The rat snake is one of them.

Snakes feed mostly on small animals like frogs

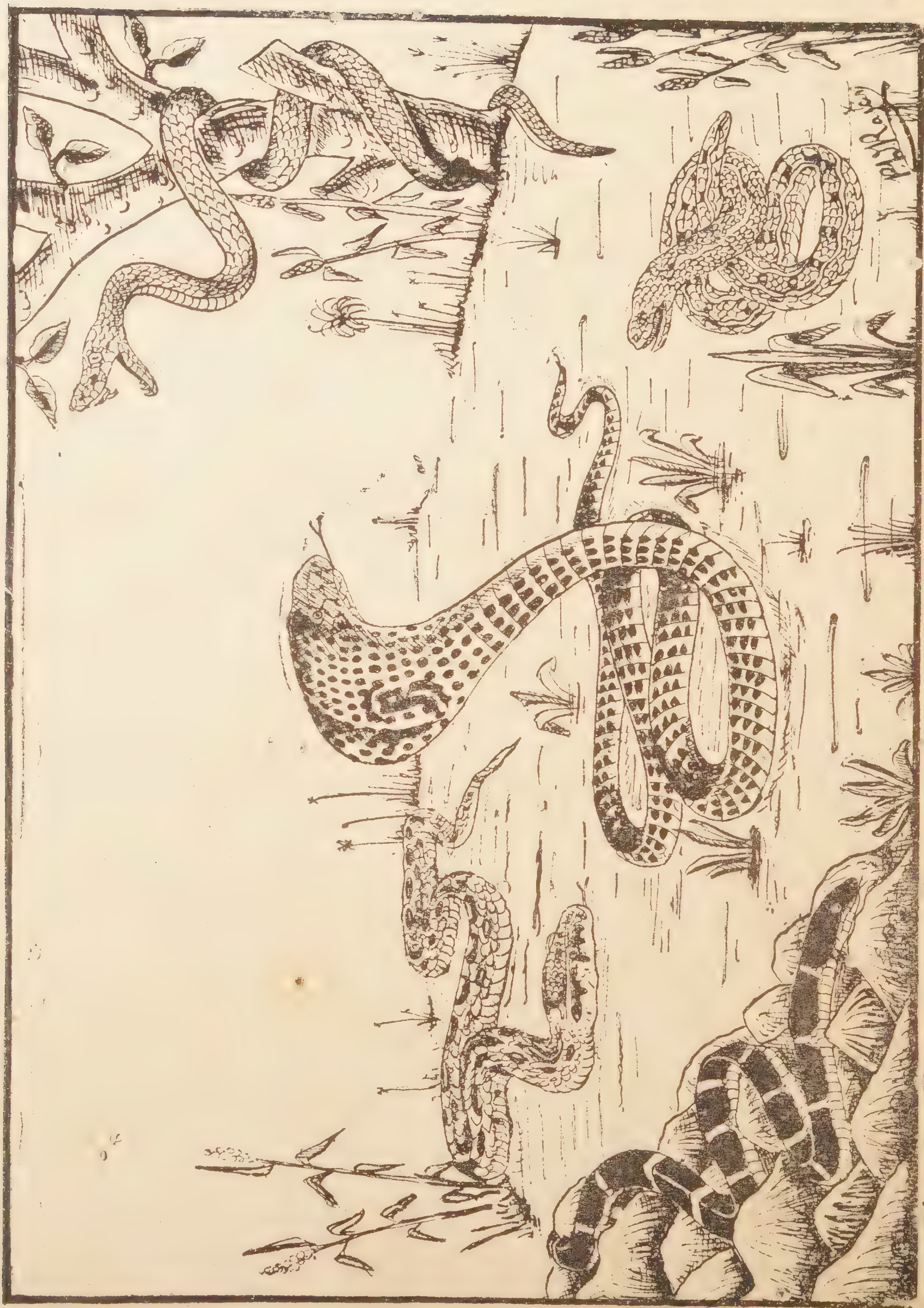

Fig. 40. The common poisonous snakes of South India. Left, foreground krait, background Russell's viper; centre, cobra; right, foreground carinate viper, background tree viper.

lizards and insects. Huge snakes like the python feed on bigger animals such as, the rat and the rabbit. They attack even lambs. Without limbs how do they catch their prey? They are very cautious and they crawl up to the prey very silently and when sufficiently near they dart forwards and catch hold of the victim in the mouth. The jaws of a ratsnake are shown in the picture. This snake is not poisonous. The jaws carry a number of teeth curved backwards. It is with these that the snake catches hold of its victim. The lower jaw of the snake is very peculiar. It is shown separately in the picture. The right half is

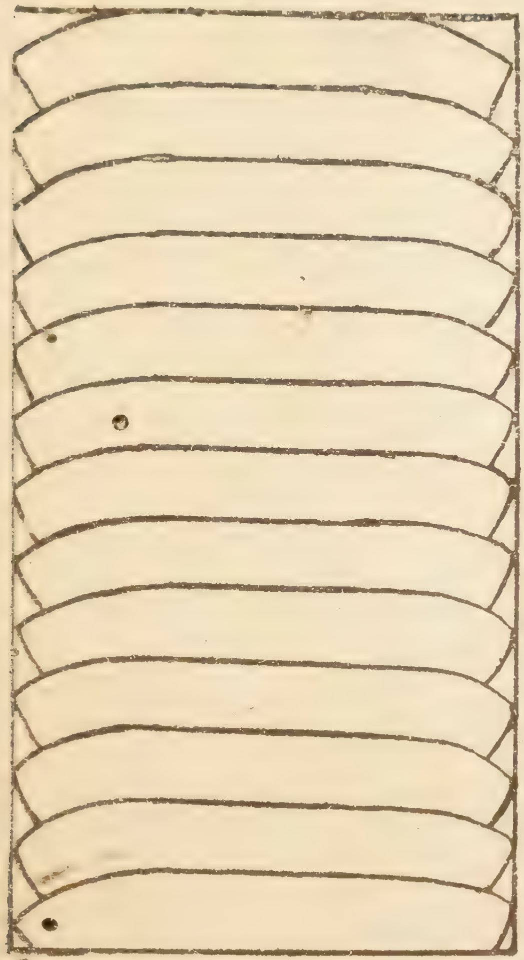
Fig. 41. Ventral scales of ratsnake.

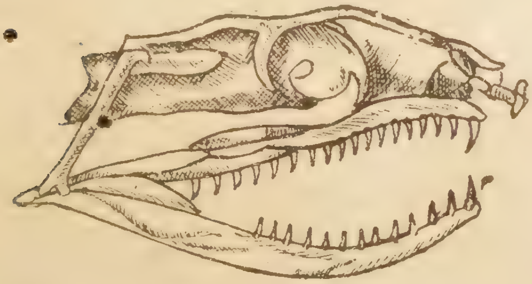
Fig. 42. Skull of ratsnake. Note the numerous uniform teeth in the lower and the upper jaw.

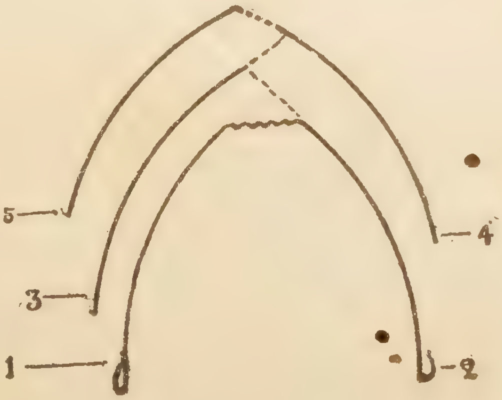

Fig. 43. Diagram to show swallowing movements of lower jaw of a snake. 1, 2, starting position of the two halves of the lower jaw; 3, left jaw is advanced; 4, the right is now advanced; 5, left jaw has again taken a fresh step forwards. Dotted line indicates ligament between the two halves of the jaw.

separate from the left. In the living animal the two are connected together in front by an elastic band. When the victim is in the mouth, the teeth of the upper jaw are hooked on to the skin of the victim preventing it from escaping. Now, one half of the lower jaw lets go, while the other half holds on. The elastic band is stretched. The mouth becomes wider. The free half of the jaw is advanced. The teeth on that jaw take a fresh hold on the body of the victim. The other half of the jaw is *now* released and takes a fresh hold on the victim slightly forwards. To help in this process the snake pushes the victim against a stone or some other object and there is copious salivation. During the act of swallowing the snake can breathe. Some of you can swim. In doing so, you strike out your arms alternately. The strokes enable you to move over the water. The working of the two halves of the jaw is similar. The snake moves slowly forwards over the body of the victim. What do you do when you want to put a cover to a pillow? You pull the cover over the pillow. The same thing happens when the snake feeds. The victim, which is the food, is like the pillow and the cover is like the snake. What happens when we eat? We take a morsel of food; it is munched well and it passes *down* the food canal. Just the reverse happens in the case of the snake. The food is practically stationary. It is the snake that passes *over* the food. This is a curious and laborious process. No wonder that the snake is tired after a meal.

Snakes like the cobra and the viper have an easier method of feeding. These, being poisonous, kill their victim first by biting them and when the victims cease to struggle they are swallowed slowly. The method of swallowing is the same.

The python is a very big snake. It is very bold and at the same time cautious. It attacks big animals like the rabbit. It approaches the unwary rabbit and throws itself upon it. The attack is sudden. The python coils its body round the rabbit, the coils are tightened and the bones of the victim are broken and the whole body crushed. The victim dies. The python swallows this mass slowly. Various kinds of snakes are kept in parks and Zoos. They are fed by throwing to them frogs, mice and other small animals. Generally they are fed once a week.

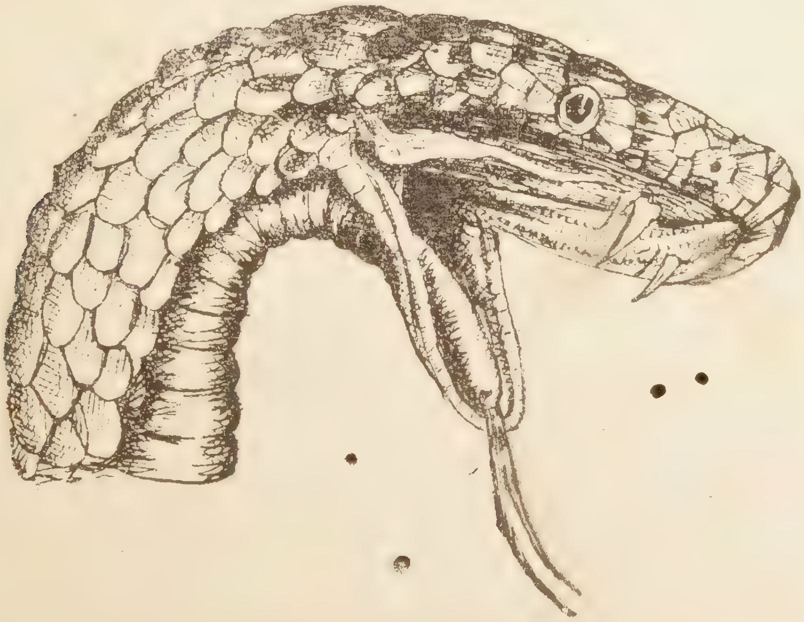

Fig. 44. Jaws of a poisonous snake. Note poison fangs and duct.

The king cobra is curious in its habits. It is specially fond of eating other snakes.

The seasnakes are peculiar. They live in the sea. Their bodies are not like those of the other snakes which crawl and whose bodies are cylindrical but flattened from side to side and the tail is like an oar. They are very poisonous. Most of the land snakes lay eggs. The sea snake brings forth young ones alive. Vipers also do this.

CHAPTER VIII.

RESPIRATION IN ANIMALS.

In the first chapter we saw that breathing is one of the signs of all living animals. Breathing or *Respiration* as it is termed is, briefly, the taking in of air or the oxygen dissolved in water and getting rid of carbonic acid gas from the blood. When we do work the various parts of our body undergo waste. The process is very similar to what happens when a candle burns. The carbon combines with the Oxygen and Co_2 is produced. This process is known as Oxidation. During this process heat is evolved. Briefly, this is what happens in our bodies. When we work, our bodily parts undergo oxidation and for this oxygen is necessary. As a result of this, Co_2 is produced. We feel warm. This oxygen, which is so very necessary for this change, is obtained from the outside, taken into the body, and carried to the various parts by the blood stream.

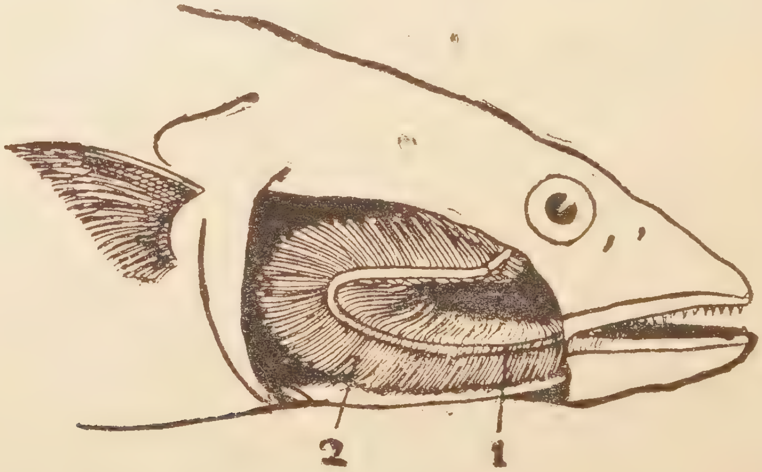

Fig. 45. Fish with gill chamber exposed. 1, gill arch ; 2, gill rakers.

Land animals obtain the oxygen directly from the air. Animals living in water take it from the oxygen dissolved in the water. We shall now consider a typical case. Let us take a fish and see how it respires. If you look at a fish, just behind the head you will see a fold. This fold is known as the *Gill cover.* If you cut away this fold a chamber is exposed. In this chamber there are four curved structures. They are the *Gill arches.* They carry a number of filaments which are richly supplied with blood vessels. When a fish swims, the various parts of the body undergo oxidation. One of the products of this is Co_2. This passes from the various parts into the veins. Gradually it is carried to the heart. From here the blood goes into a vessel starting from the front of the heart. This vessel divides into four branches on each side. These contain blood saturated with Co_2. They run up the gill arches. In this manner the blood is brought into close relationship with the outside water, with only a thin partition between, consisting of the wall of the vessel and the thin wall of the filaments. On one side of the partition there is blood rich in Co_2 and on the other water rich in oxygen. When such a condition exists, it is the property of gases to transfuse through the intervening living membrane, so that the amount of gases dissolved becomes equal

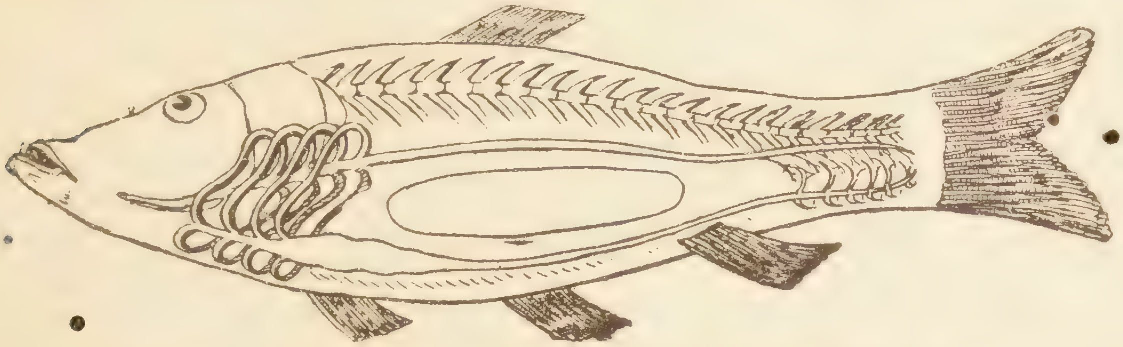

Fig. 46. Diagram to show general circulation in fish.

on both sides. Further, the red colour of the blood is due to a substance called haemoglobin. This haemoglobin has a very great affinity for oxygen. Therefore the blood brought to the gill filaments, on account of the presence of this haemoglobin, exerts, so to speak, an attraction on the oxygen which is dissolved in the outside water. The result is that the Co_2 is fully displaced from the blood by the oxygen that has been taken in by the haemoglobin. The blood brought to the gill is blue in colour due to the presence of Co_2. But when the Co_2 is displaced the blood becomes bright red and in this bright and fresh condition, it is collected by a number of other vessels and sent to the various parts of the body. This is what happens in the fish when it respires.

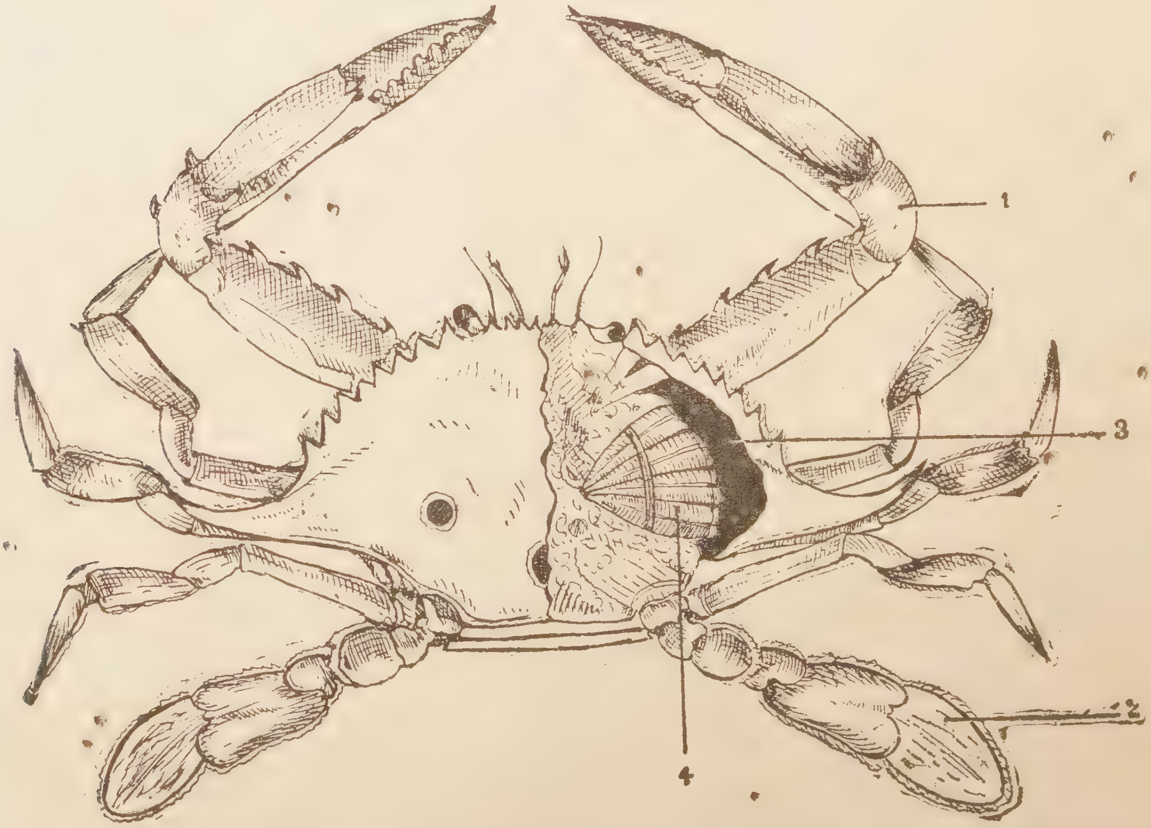

Fig. 47. Crab. Gill chamber exposed. 1, front leg ; 2, swimming leg ; 3, gill chamber ; 4, gill.

The crab is an animal which usually lives in water. Like the fish, the crab also respires by gills. The picture shows the back of a crab removed, and the gills are shown in position. These gills are plume-like. Blood is brought to them exactly as in the fish. Into the chamber containing the gills a current of water can be sent. From this water the gills get the oxygen that is necessary. Into this water the Co_2 is sent. The water in the gill chamber is constantly renewed. One important difference between the blood of the crab and that of the fish is, that in the latter, the blood is red in colour while in the crab it is colourless. This does not in any way hinder the process of respiration.

We shall now take the case of a land animal and see how it respires. The lizard, the bird and the rabbit are all land animals. We shall consider the rabbit. It breathes exaclty in the same manner as

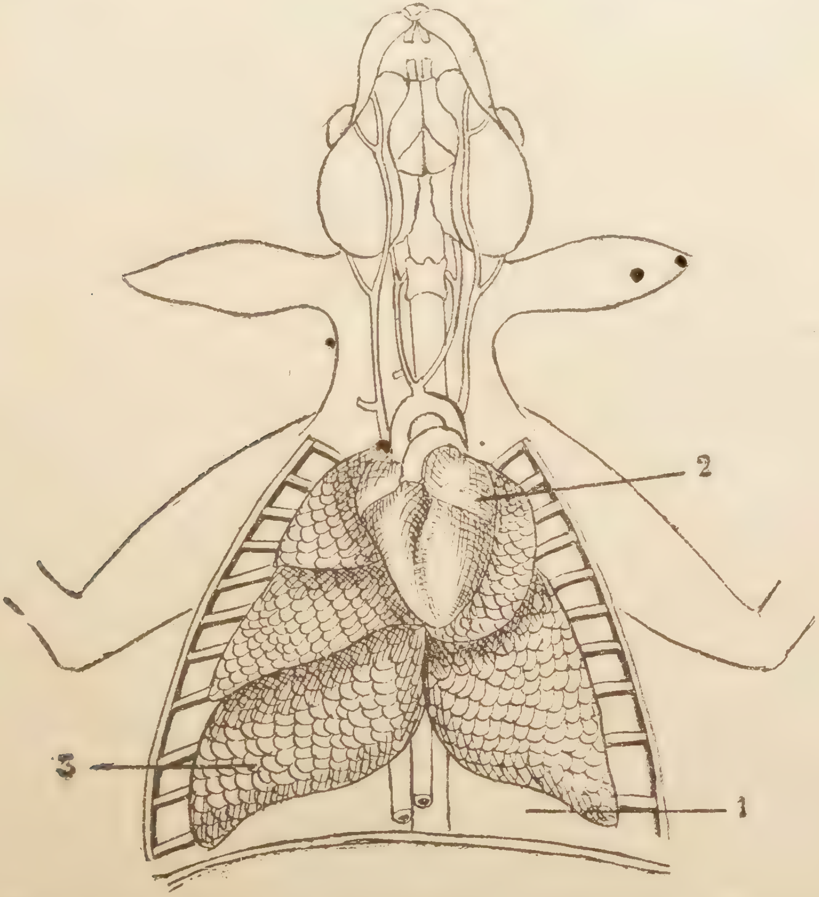

Fig. 48. Thoracic cavity of rabbit. 1, thoracic cavity ; 2, heart ; 3, lungs.

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we do. When we run or take exercise our chest rises and falls. We take in through our nostrils a quantity of air. This goes into a pair of lungs inside our chest, fills them and in consequence our chest rises. Next, our chest falls and drives the air out of our lungs. There is thus a taking in of air and a sending out of the same. The first act is called INSPIRATION and the second EXPIRATION. Both together constitute RESPIRATION. In the picture, the chest cavity of a rabbit is shown. The lungs are well seen. When the air enters through its nostrils, it gets slightly warmed and goes through a tube called the windpipe or *Trachea* and finally gets into the lungs. The inner surface of the lungs is traversed by a large number of blood vessels—*Capillaries.* Impure blood containing large quantities of Co_2 circulates in these capillaries. From the inside of the lungs pure oxygen passes into the blood and a similar quantity of Co_2 passes out of the blood into the cavity of the lungs. There is thus *an exchange of gases.* The blood now becomes bright red in colour. It is collected by another set of capillaries. These run into bigger and bigger vessels and the blood finally passes into the heart from which it is sent to the various parts of the body.

You notice that in both cases, the fish and the rabbit, the process of respiration is the same. It is merely the exchange of carbon dioxide for oxygen; but in the fish the oxygen is taken from the gas dissolved in water, whereas the land animals take it directly from the air. In both, the impure blood is brought to a particular place, the gills in one case and the lungs in the other, where the exchange takes place.

We have studied in this lesson mainly two important types of animals. There are other animals like the earthworm which have neither gills nor lungs. Here the skin performs the function of respiration. In the garden snail there is a lung cavity the sides of which act as the organ of respiration. In the landcrabs the gills have practically disappeared and in their place there is a chamber very much like a lung with blood vessels. Insects like the cockroach, grasshopper, and butterfly breathe by means of openings placed along the sides of the body. Through these air enters and is carried by means of air tubes to the various parts of the body and exchange of the gases takes place *in the tissues* of the body.

CHAPTER IX.

LOCOMOTION.

Movement is one of the characteristics of animals. To be able to move they should possess organs of locomotion. All animals do not move from place to place in the same manner. The snake creeps. Aquatic animals have a different form of locomotion. They swim. There are others, like the bird and the bat, which are able to traverse the air. They fly. In all these cases the organs of locomotion are adapted for the nature of the work they have to do.

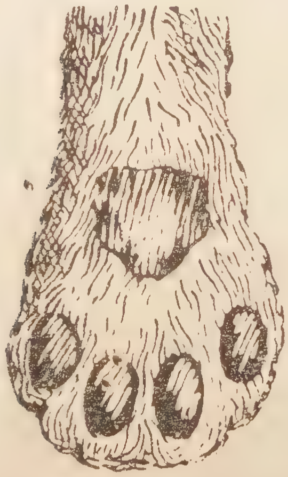


Fig. 49. Under surface of foot of cat. Claws retracted.

Let us study the cat which is a very common animal. There are two pairs of limbs, the fore and the hind limbs. The former end in five fingers and the latter in four toes. All the fingers and toes are provided with claws. If you examine the under-side of a leg of the cat, it will be very much like the picture given on this page. There are a number of cushion-like pads. When a cat comes into a room you hardly notice it. It moves on the pads so silently. It is a great advantage to it to be able to move in this manner. Even when it jumps from a window to the floor you do not hear any noise. The cat lives upon rats and mice and has to be very cautious and silent, if it is to catch them. It is able to approach them very close before they become aware of its presence. The cat does not run down its prey but prefers to lie in wait or creep silently on to it, thus taking it unawares. The claws will get blunt every time it jumps, if they were not

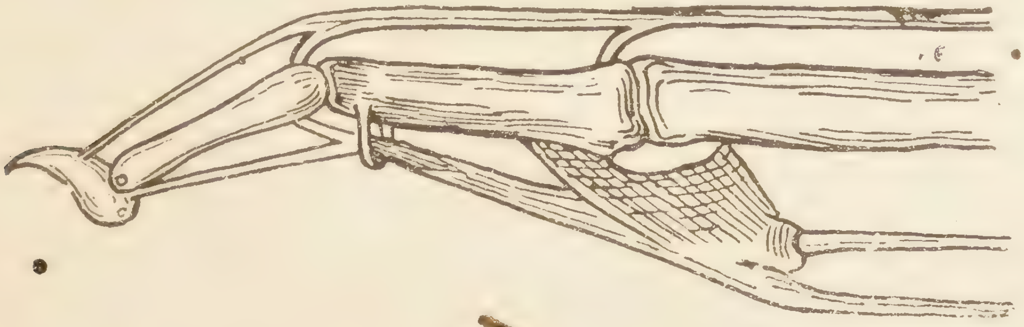


Fig. 50. A toe of cat. Claw pushed out.

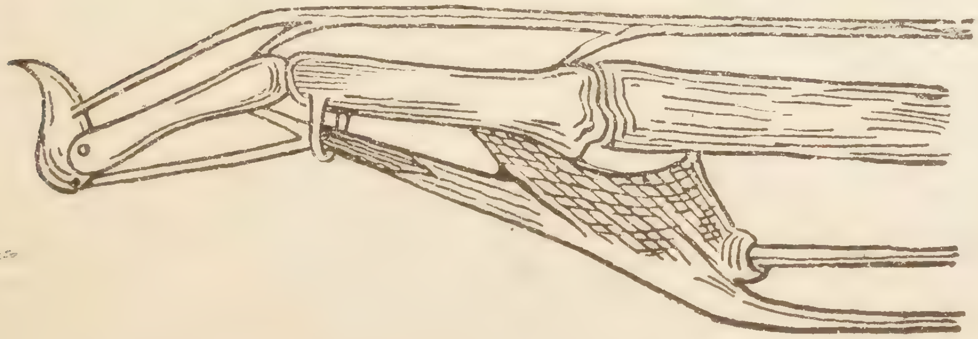


Fig. 51. A toe of cat. Claw retracted.

drawn in. So you see that the pads and the retractile claws are in accordance with the food procuring habits of the animal.

Now look at the bones of the front leg of a cat and compare them with those of the human arm. The bones are shown in the picture. There is an upper arm bone corresponding with the upper arm bone in us. Then there are two long slightly smaller bones. These correspond to the forearm bones. Then there is a group of bones, the wrist bones, and finally there are the bones of the palm and the fingers. The general arrangement is very much like what it is in the human arm. Our arm can be bent at the shoulder, at the elbow, at the wrist and between the

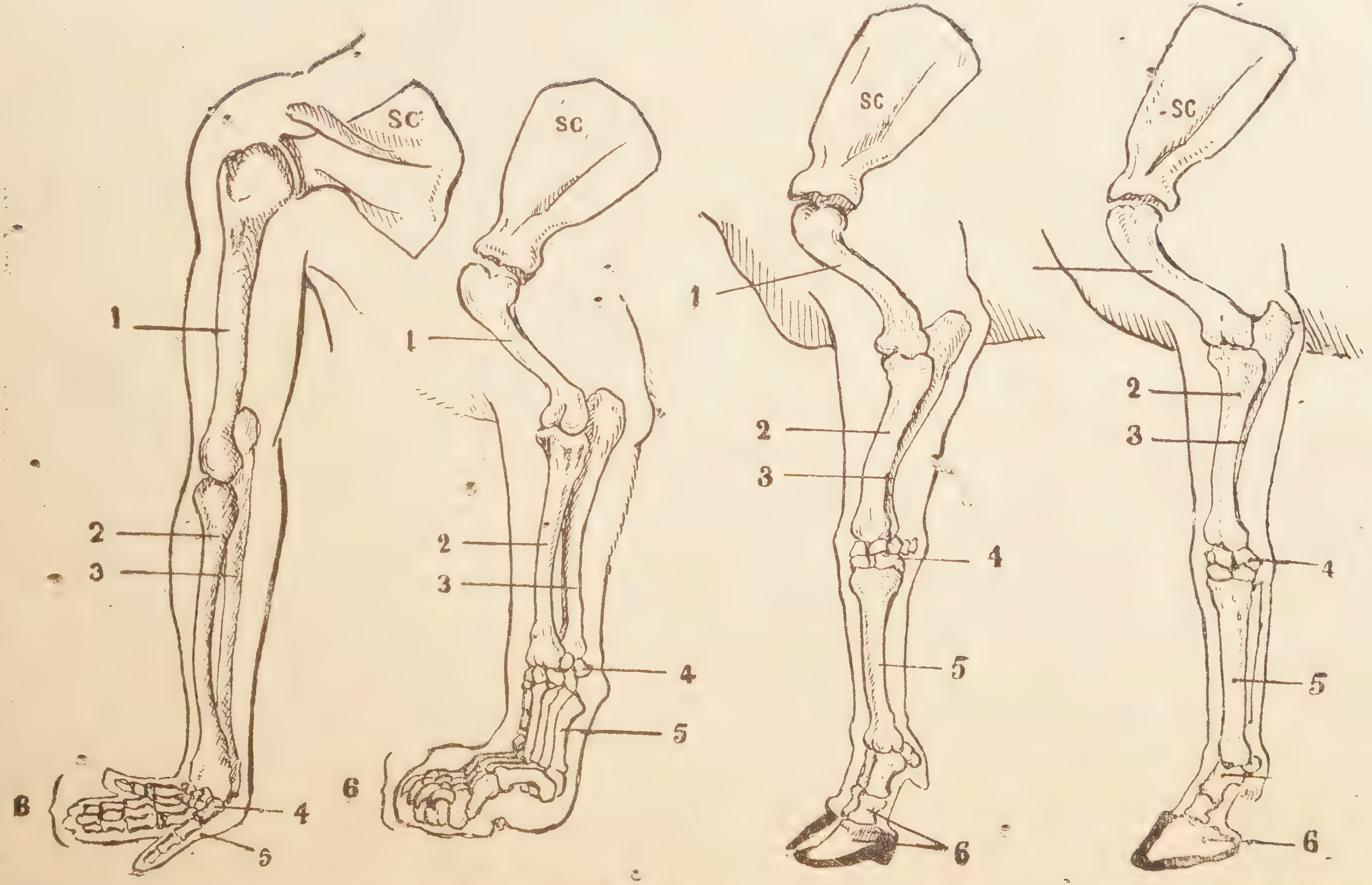


Fig. 52. Shows in order from left to right the hand of a man, the front limb of a cat, a cow and a horse. 1, Upper arm bone (humerus); 2, 3, fore arm bones (Radius and ulna); 4, wrist bones (Carpals); 5, Palm bones (meta carpals); 6, digits. Sc, shoulder blade (scapula).

fingers. In the case of the cat it is exactly the same. The front limb of the cat is really its arm. There are, therefore, nearly the same bones in the front limb of the cat as there are in the arm of man. The cat is a toe walker.

We shall now go on to the cow. Like the cat, it has two pairs of legs. But what a great difference between the ends of the limbs of a cat and the ends of those of a cow! Instead of the five fingers and four toes as in the cat, the cow has only two. These toes do not end in claws or nails, but in strong horny hoofs. Why is this? We can explain this by understanding the habits of the cow. The cow loves to eat grass. It goes to soft marshy grounds where there is plenty to eat. Its foot is cleft and so the soft earth runs up between the two hoofs and enables the foot to sink easily, thereby preventing the animal from slipping. Again the cow has to walk long distances carrying its heavy body over hard surfaces. The feet are therefore subjected to very great wear and tear. That is another reason why they are provided with hoofs.

We shall now examine the bones of the front limbs of the cow. They are well shown in the picture. The arm appears to be lengthened. There is one bone supporting the upperarm, and one of the two forearm-bones is well developed. The other is reduced. There is here, as in the other cases, a group of wrist bones. When a cat places its front limb on the ground, its wrist bones are only slightly raised from the ground. When we place our hand on the ground, with the palm spread out, our wrist bones are in a level with the ground.

Look at the limb of the cow now. In the standing position the wrist bones are well raised over the ground. This is due to two of the palm bones having united and also to their having elongated. There are five fingers in the cat but there are only two fully developed in the cow. The finger corresponding to the thumb is gone, and those corresponding to the index finger and the little finger are reduced and do not reach the ground. The remaining fingers are well developed. Their ends are enclosed in horny hoofs. The legs have to carry enormous weight and the bones have to be strong. That is why they are arranged in a *vertical* manner so that the weight can be carried easily. The lengthening and the union of the two palm bones is to give greater speed to the animal. The hoofs enable the animal to walk on hard ground.

Let us now consider the horse. It is one of the fastest of animals. Its limbs are powerfully made. There is only one large hoof in each leg. The bones in the front leg are very similar to those of the cow. Here also the wrist bones are raised well above the ground. Below the wrist bones there is a long bone. It is the middle bone of the palm elongated. Beyond this, there are the three joints of the middle finger which alone is present here. The others are gone. The last joint is ensheathed in a big hoof. There is great similarity between the cow and the horse, but there are two fully developed fingers or toes in the cow, whereas in the horse, there is only one. They both walk on the tips of their fingers and toes.

There are other animals which, like the cow, have split hoofs. The deer and the camel are two such animals. The ass and the zebra have only one hoof in each leg.

All these are adapted for locomotion on hard ground. Many animals like the bear place all the palm bones and the foot bones on the ground in walking. Such animals cannot run fast.

EXERCISE

Request your teacher to show you the skeleton of the leg of a cat, a cow and a horse. Draw them and note the corresponding bones. Observe the feet of a living cat and note the retractile claws and the cushionlike pads on the under surface.

CHAPTER X.

JUMPING, THE WHY OF IT

We have considered in the previous chapter the method of locomotion of the cat, the cow and the horse. Running is the common mode of locomotion in these animals and for that purpose the anterior and posterior pairs of limbs are equal in length. There are many animals in which running is not the method of progression. All of you know the grasshopper. It jumps from place to place. It has three pairs of jointed legs. It does not run in the grass. What about the frog? Those of you who have tried to catch a frog will have noticed that it usually leaps long distances and escapes you. Some of you have also been to the Zoo. There, you have, probably, seen the kangaroo. It is an Australian animal. It also takes very long jumps. In all these cases jumping is the characteristic mode of locomotion.

The grasshopper has three pairs of legs of which two are, more or less, equal in length while the last pair is longer and more powerfully built than the other two. Its chief enemy is the Mina. There are other birds also which would have the grasshopper for a meal. The best way for the grasshopper to escape from a bird is not to run, for in that case the alert bird can easily overtake it, but take a long leap from the place, as this makes the bird lose

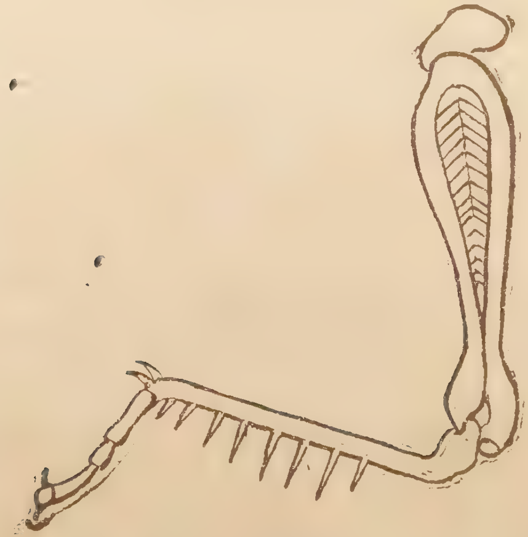


Fig. 53. Hind leg of grasshopper.

sight of it altogether. How does the grasshopper leap? When it is disturbed by a bird and wants to escape, it kicks, so to speak, with its hind legs against the ground, and the force of this throws the insect into the air and so enables it to take a very long jump over a great distance.

The frog also jumps, when on land. If you disturb it when it sits at the edge of the water, it takes a leap and falls into the water far from your reach. If you catch it and hold it gently in your hand and compare the hind-limbs with the forelimbs, you will notice that the former are more muscular, longer and better developed. It is because of this that the frog is able to jump so well. The chunam frog, which comes into the houses and sticks on to the walls, can also jump very well. Its hind legs are also very long and muscular. If you watch a frog jump, you will see that it straightens its hind legs quite suddenly thereby giving a kick to the ground. This throws it into the air and so a jump is effected.

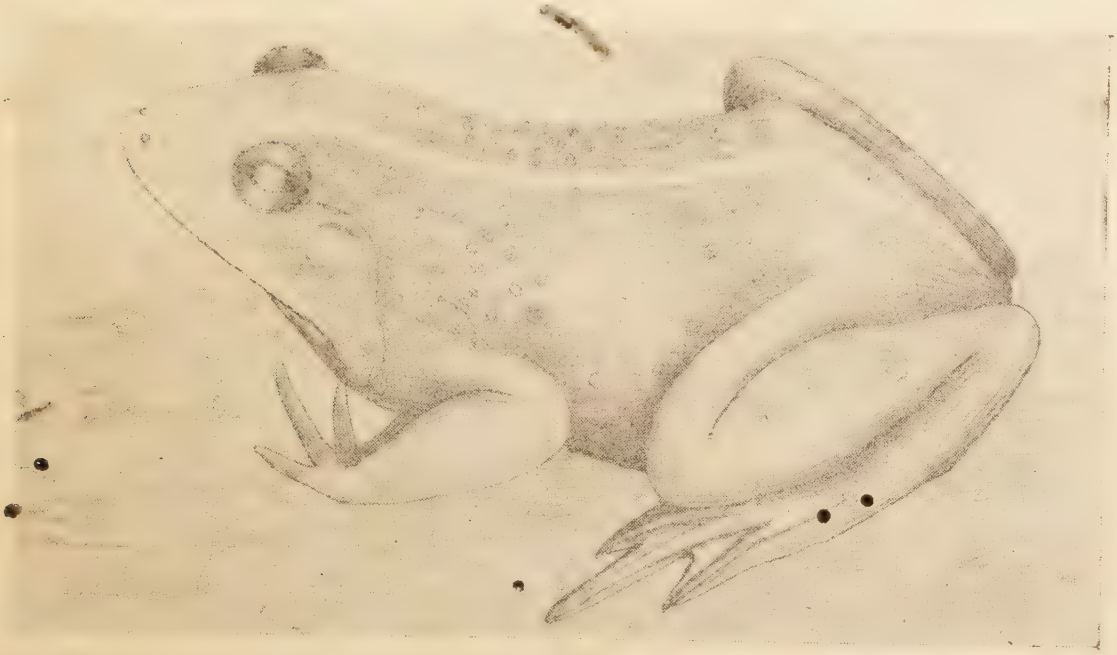


Fig. 54. The common Madras frog.

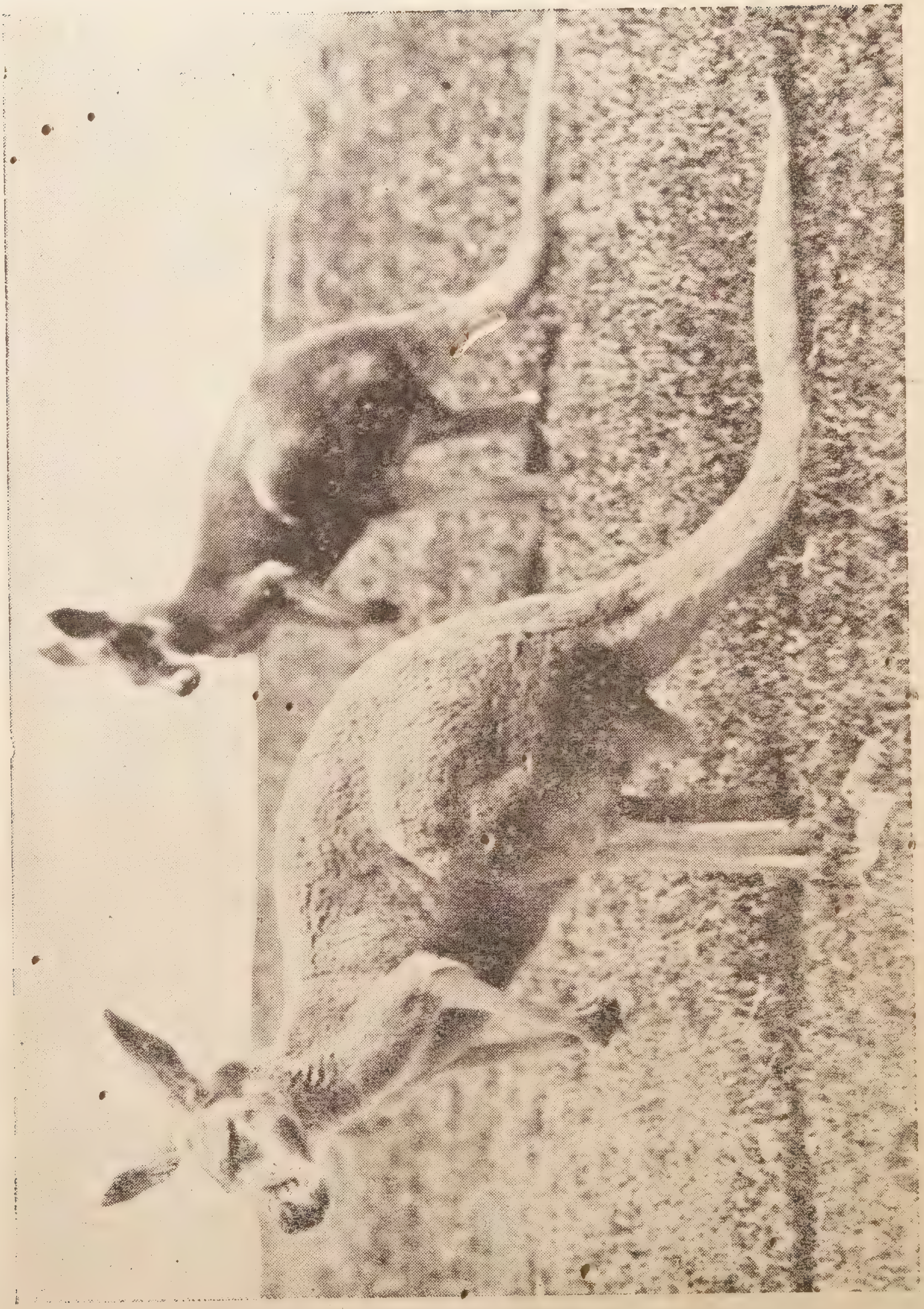


Fig. 55. Kangaroo.

Courtesy, Australian Govt. Photographs

The Kangaroo is another jumping animal. A full grown kangaroo measures about 6 feet in height. Its front limbs are short. Its hind limbs are long, strong and muscular. This curious animal moves from place to place by long leaps. It is said that a big kangaroo can cover 20 feet at each leap.

There are other animals which have a similar method of progression. The hare, when it wants to escape from its enemies, does so by taking long leaps. Here also the hindlimbs are longer than the forelimbs. Speed to many animals is a matter of life and death. All helpless animals try to escape from enemies by running away. The deer is a fleet footed animal. Its legs are slender and well developed for rapid locomotion on hard surface. It may be said generally that speed is a characteristic of defenceless animals. It is especially so if the animal is herbivorous also. The grasshopper, frog, kangaroo and the hare are all defenceless. They have numerous enemies. They have no teeth or sharp claws to fight with. They can only run away from the foes that pursue them. Death is the penalty for not doing so. That is why defenceless animals have developed the capacity for speed. That is also the reason why the hind limbs are very much longer than the front ones enabling them to take long flying leaps.

EXERCISE

Watch the grasshopper and the frog in their natural surroundings. Observe how they move and feed.

CHAPTER XI.

CRAWLING ANIMALS.

The world is full of animals, though it doos not appear to be so. All living things need food and shelter. Some are strong while others are weak. The strong pursue the weak and the latter either run away or try to hide. Such a thing is natural. You know the earthworm. It is a soft cylindrical animal growing to a length of 6 to 9 inches. The round body is made up of a number of rings. It comes out in the mornings and very soon retreats to its burrow before the sun rises. It is a very timid creature. During the rainy season you can see it coming out of its burrow and creeping on the ground. How is this creature adapted to the life it leads? It has no eyes to see nor has it organs of defence. If you take a worm

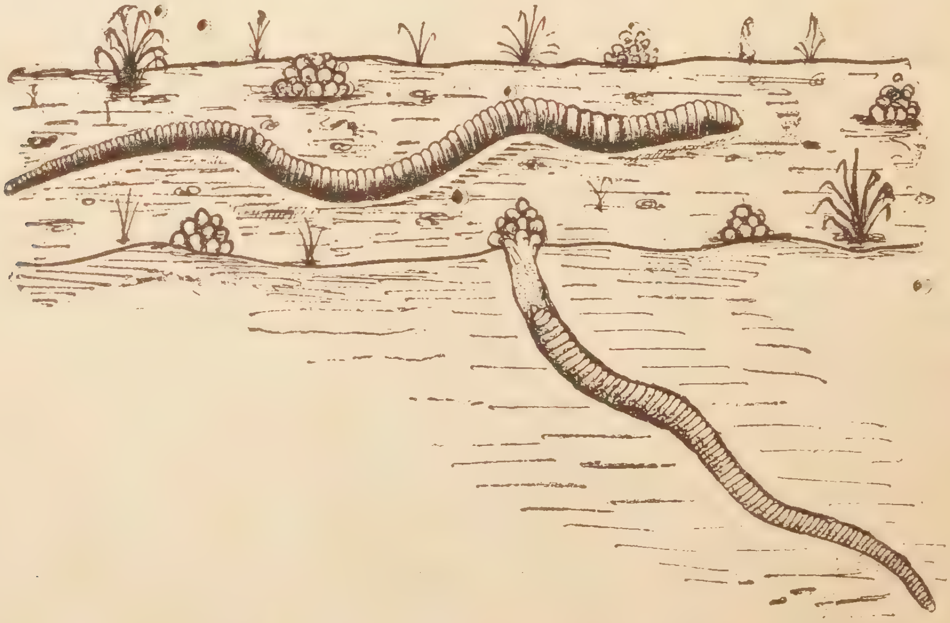


Fig. 56. The earthworm at home.

in your hand and pass your fingers along its body from one end to the other and back again, you will notice that, in one direction, the skin feels rough while in the opposite it is smooth. You feel the roughness when you pass your hand towards the front end. It is due to the presence of a number of small bristles placed in the body rings of the animal. They are always to be found on the lower side of the worm. These are the structures that enable the creature to crawl. In crawling the bristles are pressed against the surface of the ground and the worm pushes itself forward. The food of the earth-worm is peculiar. It has no organs with which to catch any animal for food. It is content to swallow small quantities of soft earth in which are contained bits of decaying leaves. The earth as well as the vegetable matter are both passed through the food canal of the worm. What little nourishment there is in the earth is absorbed and the useless matter is thrown out at the hind end in the form of small pellets. These pellets are known as worm castings. This is really the earth that has passed through the food canal of the earthworm. It may be said that the earthworm eats its way into the

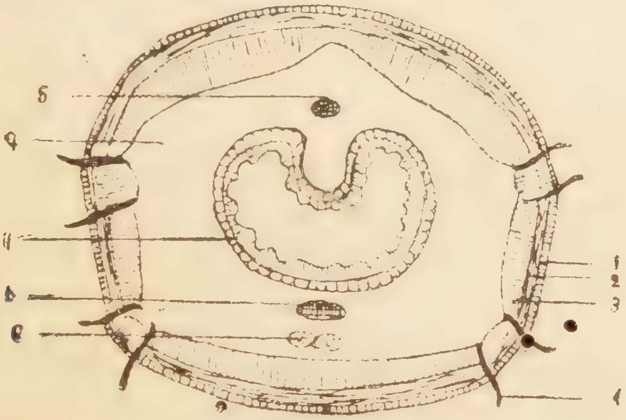


Fig. 57. Diagram of a transverse section of an earthworm. 1, skin; 2, circular muscles 3, longitudinal muscles; 4, a seta; 5, dorsal blood vessel; 6, ventral blood vesel; 7, intestine; 8, nerve cord; 9, body cavity.

burrow. Sometimes when it comes out, it is caught by a mina, which takes hold of one end and pulls it out of the burrow. The worm often snaps. The hind end of the worm is swallowed by the bird. But the earthworm is not killed. The head end of the worm which is still left in the burrow is not very much the worse for having lost a portion of its body. It easily grows. This power of renewing a lost part is a method of defence and is common in many worms.

We see why the earthworm must hide from its enemies. This it does by burrowing into the earth. The body is very soft and long and so often gets damaged. Therefore it is advantageous to it to be able to *regenerate* portions of its body.

The snail is another creeping animal. It also moves very slowly. If you watch it crawl on a glass plate you will notice that its foot is flat and soft. It is able to adhere to the glass plate. The crawling surface of the foot is pale white in colour and while crawling wave-like contractions are found to pass along the foot. It also leaves a sticky substance along the surface on which it has crawled. This slimy substance oozes out of a particular spot. It is on a surface made slimy that the snail crawls. Thus the friction on the soft foot is reduced. Being a slow soft bodied animal, the snail is subject to many dangers. But it is a very cautious animal. On the head are four fingerlike feelers. The eyes are on the hind pair of feelers. They are very sensitive. By their help the animal feels its way. When danger threatens, it withdraws its head, foot and body into the shell and is then safe. Snails are fond of cold weather and rain and then they come out in large numbers. Their bodies must always be kept moist. During hot weather they retreat into their shells, close up the mouth of the shell with a small quantity of slime, and spend the hot weather in this manner till rainy weather returns. They can be made to crawl out if placed in a little water.

The snake, like the earthworm, crawls. Since it does it rapidly it may be said to glide. In most snakes the ventral scales are enlarged and then the hinder edges which are attached to the tips of the ribs are planted against the inequalities of the ground and the body of the snake is pushed forwards and a crawling form of locomotion results.

EXERCISE

Go out in the early morning into the garden. Search in moist places for the burrows of the earthworms. Observe their castings. Dig out one or two worms and feel their body surface.

CHAPTER XII.

BURROWING.

Animals generally avoid being seen. They try in various ways to conceal themselves. The relationship between animals is very much like that between the hunter and the hunted. The hunter approaches cautiously the animal that he wishes to kill. He knows that if he makes any noise the animals would escape. The animals know also that, if they expose themsleves unnecessarily, they will be seen and killed. The cat waits or moves on padded toes on the lookout for mice. The hunted hide themselves in holes or corners and when discovered try to escape by superior speed. When the cat knows that its presence is discovered, it no longer waits but pounces on the prey. So, both the cat, which is the hunter, and the mouse, which is the hunted, require caution, concealment and speed, each for its own purpose. No mercy is asked and no quarter is shown. *This is the law of nature.*

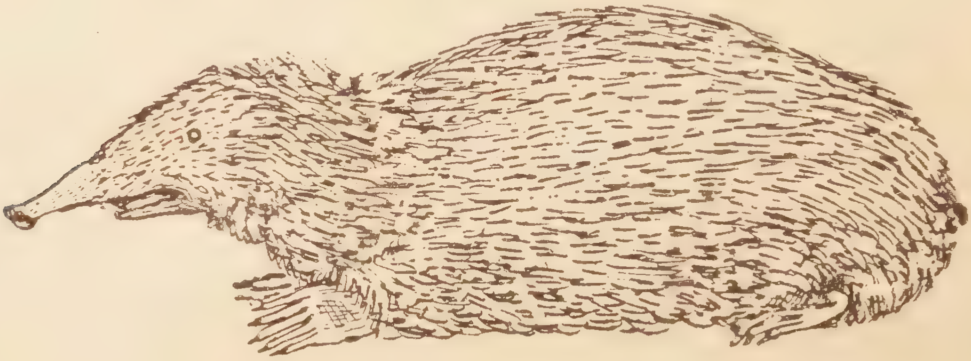


Fig. 58. The mole.

There are many animals, which to avoid being seen by their enemies, have adapted themselves to live in holes and burrows. They are generally animals which have lost the battle of life. The mole and the mole-cricket are two such examples. The former is not an animal common in India. In South India, it is entirely absent. It is found in certain places near Darjeeling in the Himalayas. It is very much like the house shrew. Both are insectivorous, that is, they feed mainly on insects. They hide during day time and come out during nights. Moles live in burrows. The body is short and cylindrical. It has a dense covering of soft hair. Living, as it does, in cold regions this dense covering of hair keeps it warm. The arms are short and tipped with strong claws. Long limbs will be of no use in burrows but will be a hindrance as they cannot be moved about in the little space that is available. Long limbs are no use in digging. We do not dig with a long pole but use short, strong instruments. It is dark in the burrows. The mole cannot see well. Its *habitual* life in the dark has made its eyes practically useless. In consequence, the eyes are very much reduced. Thus by its body shape, nature of the limbs and claws, warm covering of fine hair, the mole is well adapted to lead the life of a burrower.

The mole-cricket is another burrowing form. It is an insect and is very much like a cricket or a grasshopper, but as it burrows like a mole it is called the *Mole*

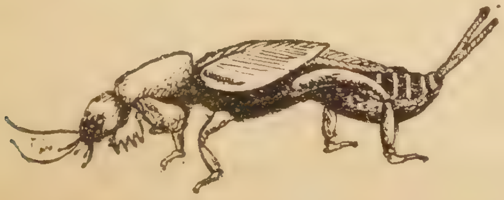


Fig. 59. Mole cricket.

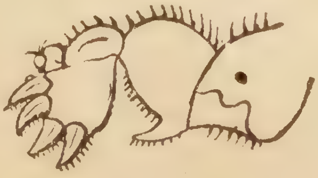


Fig. 60. Front leg of mole cricket; note slit-like 'ear'.

cricket. We have seen that the grasshopper has its hind legs well developed for the particular mode of life it leads. Jumping is of no use to the mole cricket. It lives in burrows which it makes in soft earth. You can get them easily if you turn up wet garden soil. Its body is stout and strong. Like the grasshopper, it has three pairs of legs but they are quite differently shaped. If you examine them closely, you will see that the front legs are very stout, hard and strongly clawed. A leg is shown in the picture. When it burrows it has to clear the earth and also to cut through roots. While the mole cricket burrows it is very cautious. It listens to the approach of its enemies. It has no ears like those of the cat or the rat. Instead, on one of the joints of each one of the front legs, there is a slit-like opening which is really an ear. Perhaps by means of these structures, it is able to detect the vibrations in the earth which an enemy must make in approaching it.

The mole cricket cannot fly very much. Its wings are very small. Large wings are not suited to an animal that lives in burrows, just as long legs are.

All of you have seen cockroaches in your houses. They frequent the kitchen. They run with great speed. If you catch one and examine its legs you will find all of them are of the same length almost. Running insects have similar legs. Jumping insects, like the grasshopper, have their hind legs elongated, while burrowing forms, like the mole cricket have their front legs well developed.

EXERCISE

Find the homes of the molecrickets in the garden. Watch them burrow rapidly when they are turned up with the soil. Take up one and note the difference in the size and shape of the legs. Also observe the reduced wings.

CHAPTER XIII.

SWIMMING.

Animals do not live on land alone. There are many which are aquatic. Some of them crawl at the bottom of the sea. Others float passively at the surface. Yet others live like the fish, actively swimming. The fish is an excellent swimmer. Every part of its body is well adapted for this purpose. The parts of a typical fish are shown in the figure. The body tapers at both ends like a spindle and therefore is well suited for cleaving through the water with ease. It is covered with closely fitting scales which are kept smooth and slippery by slime or mucus and this adds to the ease of movement in water. The body consists of a head, trunk and tail. There is no neck. A slender neck would be a hindrance. Organs of locomotion are the fins. There is a pair of anterior or the *Pectoral fins* placed immediately behind the gill cover. Some distance behind, there is another

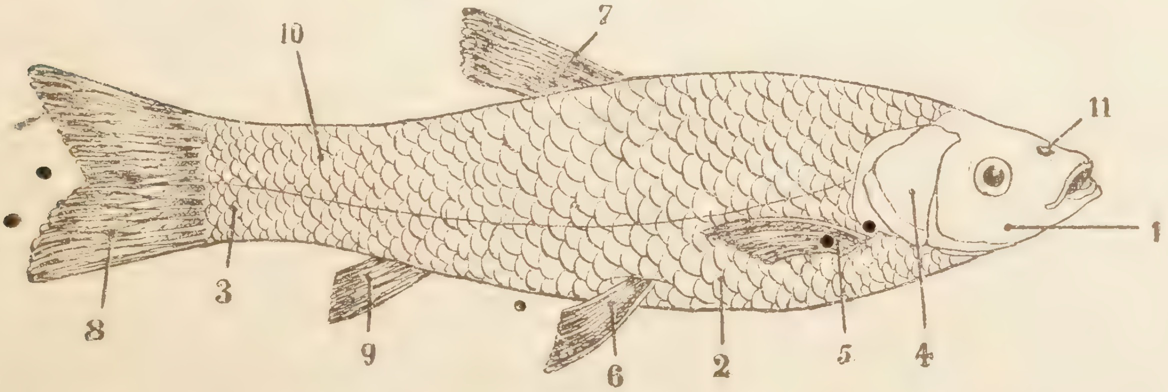


Fig. 61. A common fish. 1, head; 2, body; 3, tail; 4, gill cover; 5, pectoral fin; 6, pelvic fin; 7, dorsal median fin; 8, tail fin (median); 9, anal fin (median); 10, scales; 11, nostril.

pair placed on either side. These are the ventral or *Pelvic fins.* The pectoral and pelvic fins are called the *Paired fins.* Besides these, there are other fins which are placed along the median line of the body and not at the sides and are called the *Median fins.* On the back there is a fin called the *Dorsal fin.* At the end of the animal there is a strong fin, the tail or *Caudal* fin. On the under side of the body, between the caudal and the ventral, there is a fin called the *Anal fin.* This is the general arrangement of the fins in the body of a fish. There are many differences in the arrangement in different fishes. The fins are supported inside by structures called finrays. If you watch a swimming fish in a glass tank or vessel, you will see that the tail fin is the most active of all the fins. It is by strokes of the tail fin that the animal is sent forwards. Consequently the tail fin is the chief organ of locomotion. In fact, it serves the function of a propeller. The median fins enable the fish to keep a straight course. If they are damaged or removed, the fish will wobble instead of going straight. When the fish wants to turn to the right or left, the paired fins come into play. When turning sharply to the right, the paired fins on the right side are kept pressed to the body and those on the left work actively and vice versa. All the fins together enable the fish to maintain its natural position in water. If we remove all the fins, the fish will float with its belly up. This is because the upper side of the fish, along which the back bone runs, is heavy.

The turtle also lives in water. It is not a fish. It belongs to the same group of animals as the lizard, the crocodile, the snake and the tortoise. All these breathe by lungs. In this respect they differ from the fish. Lizards live on land. Crocodiles and turtles have given up living on land and have taken to water. The turtle especially has adapted itself very well to water. The

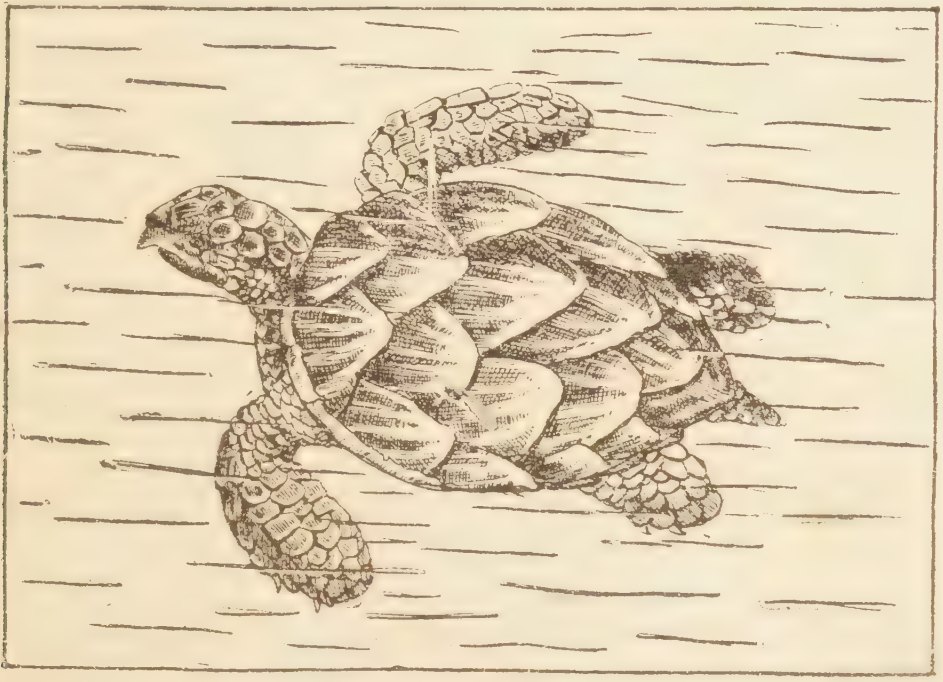


Fig. 62. A marine turtle. (Hawksbill).

figure shown is that of a marine turtle. It is called the Hawksbill. It is flattened from above downwards. It is an air breather and therefore lives near the surface, and for this purpose a body flattened in this manner will be very useful. But the most important adaptation that has taken place is in the limbs. They have all become flattened and paddle like. When you swim, you float on the surface and push the water backwards by powerful strokes of the hands and feet. This is exactly what the turtle does. In swimming, it keeps to the surface. When it goes down, as it often does, it has to come back to the surface to take in air. There are turtles of many kinds. All of them come to the shore to lay eggs.

EXERCISE

Place a fish in a glass vessel and observe carefully how it uses its fins.

CHAPTER XIV.

THE CONQUEST OF AIR.

The universe is full of animals of various kinds. They must all feed. But there is not enough food for them in one place. It is therefore advantageous for them to get scattered so that they may get the food they want more easily. If all the animals live together, not only will there not be enough food, but also they will have to struggle among themselves for the little food they have. There is, therefore, in animals, a tendency to get away from each other in search of more and more comfortable places to live in.

Many animals have left the land and learnt to fly. The problem of flight is a very ancient one. Many animals have solved it, first the insects, then some reptiles which have now disappeared from the earth and then the birds and last of all the bats. It is a great advantage to be able to do so. Animals can move from place to place quickly and can therefore search for food in places widely separted. They have thus a greater chance of getting all the food they want. But to be able to fly their body must be adapted for flight. The conditions of life of aerial animals are peculiar. It may therefore be expected that their bodily structure will also be different. Birds may be said to be the only group of animals that have successfully adapted themselves to life in air. Bats have done so to a lesser degree.

Let us now consider how the bird flies. The body of a bird consists of a rounded head, a neck and a trunk. There are two wings in front and a pair of legs with four toes behind. The whole body is covered with feathers.

In the vertebrates the two pairs of limbs are generally similar. In the fish they take the form of fins. In the frog, lizard, rabbit and monkey they take the form of limbs. But in the bird the anterior limbs have been modified as wings. The picture of a wing is shown here. Covering it there are many feathers. They have a definite arrangement and are all directed backwards. The whole wing is supported internally by a number of bones. These bones have the same general arrangement as the bones of the front limb of a normal vertebrate. There is an upper arm bone, two forearm bones and a group of wrist bones followed by three digits. The wrist bones and the bones following the forearm are slightly modified. The wing is therefore only the highly modified anterior limb of the animal.

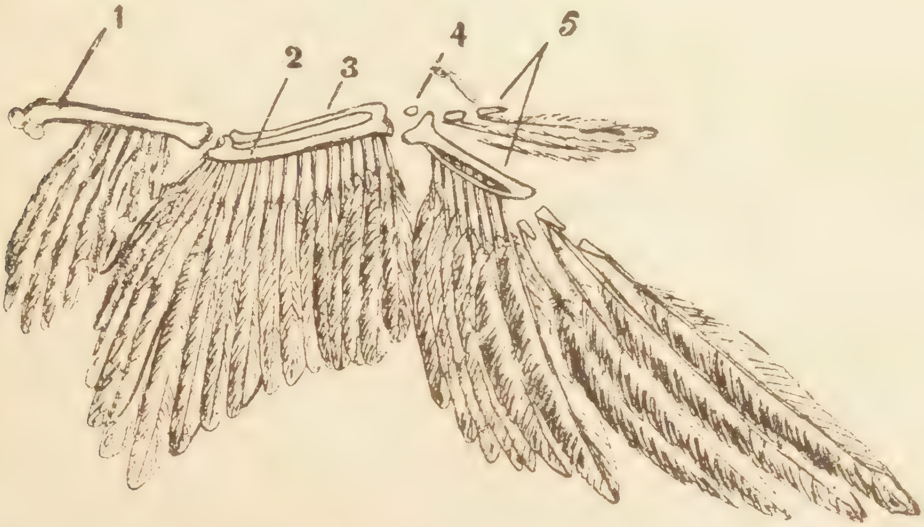


Fig. 62. Wing of bird. 1, upper arm bone ; 2, 3, forearm bones ; 4, wrist ; 5, fingers.

The feathers are very light and non-conducting and keep the body warm. They are also so made that no water can penetrate them and wet the body. The structure of the feather is shown in the figure. In shape it is like a long leaf. There is a stalk called the *Calamus.* Then there is the midrib called the *Rachis.* The expanded portion is called the *Vane.* It is formed of a number of closely arranged *Barbs.* They are placed one behind the other on either side of the rachis. In the natural condition the barbs are fastened to each other by hook like structures. The result is that the barbs of the feathers hold on pretty firmly and do not allow any water to penetrate through them. In this way the feathers keep the animal not only warm but also free from wet.

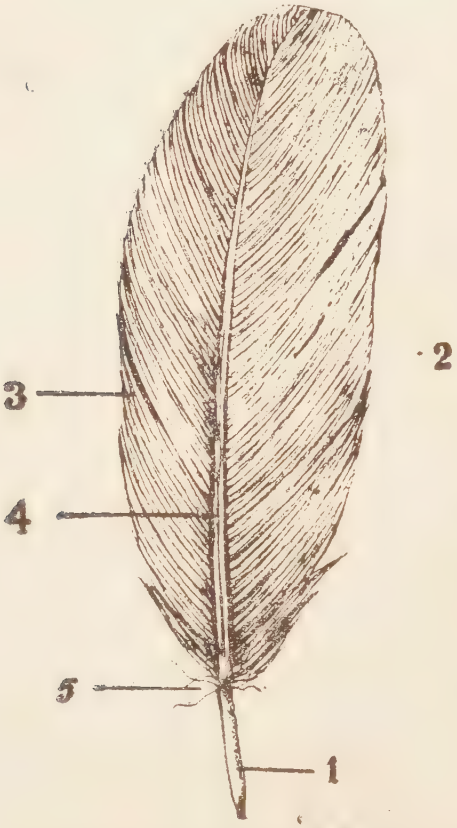


Fig. 63. General appearance of a feather. 1, calamus; 2, vane; 3, barbs; 4, rachis; 5, after shaft.

Let us now compare the wing of a bat with that of a bird. Bats are MAMMALS. They have teeth. They bring forth young ones alive. In the bat the anterior limbs also are modified into wings. The wing of a bat is shown in the figure. You will see that it is entirely different from that of the bird. There are no feathers here. There is only a thin membrane passing from the neck of the animal along the side down to the hind limbs. This membrane is elastic and is called the *patagium.* It is spread over the elongated bones of the anterior limb. You see the bones very well in the figure. The palm bones and finger bones are very much elongated and serve the same purpose as the ribs of an umbrella. They keep the patagium stretched out. The bird and the bat belong to entirely different groups.

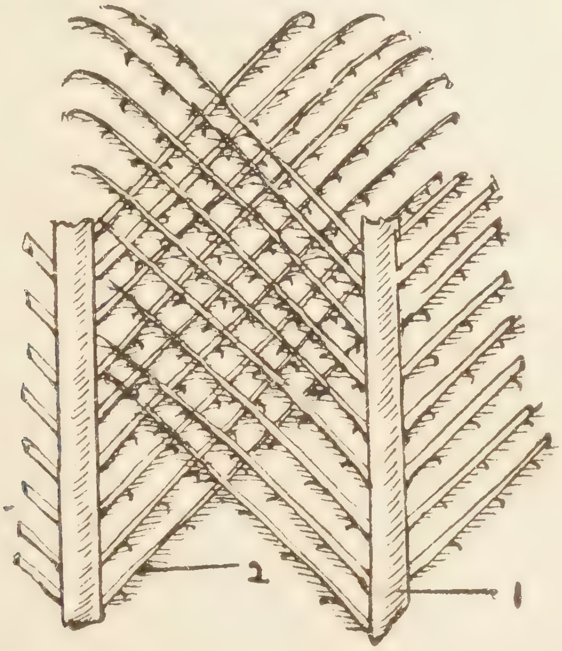


Fig. 64. Arrangement of barbs and barbules. 1. barb. 2. barbules.

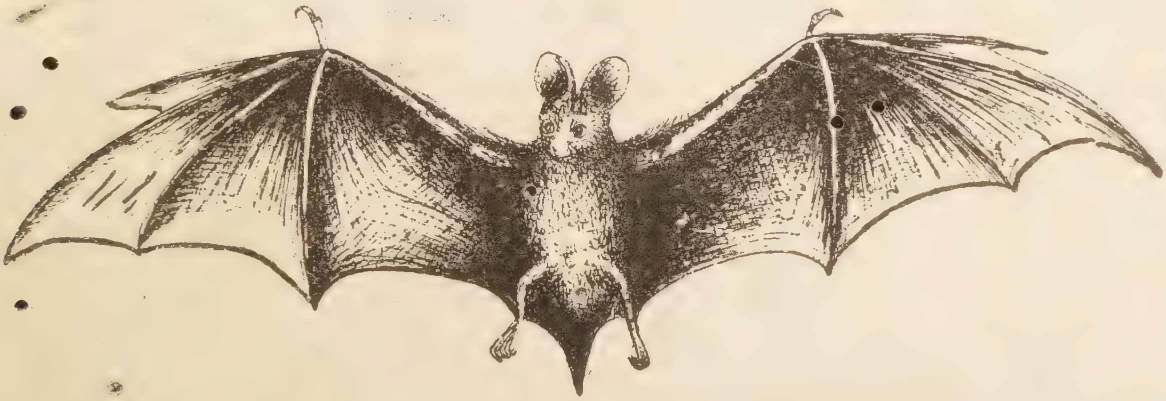


Fig. 65. Bat showing wing membrane stretched.

Both of them have become adapted to life in the air. It is interesting to note that in both cases the anterior limbs have become modified to perform the function of wings.

There are other animals which fly. The insects are good examples of this. You have learned something about some of the insects. An insect's body consists of a *head*, a middle region the *thorax*, and the third region the *abdomen.* From the thorax two pairs of wings arise. Many insects habitually fly. The butterfly, the house-fly, the mosquito and the dragon fly are all examples of this. They have two pairs of wings. But the house-fly and the mosquito have only one pair each. Many of the insects have lost their wings, like the bedbug. When the wings are present they *are always the flattened expansions of the skin of the back.* They are not modified limbs. But they serve the same purpose as the wings of the birds and the bats. To make them fairly rigid they are supported by structures known as *nervures* which form a network, inside which air tubes run. Some insects can fold their wings. In some, the wings are transparent like those of a dragonfly, membranous as in the case of the honey bee, or opaque and beautifully coloured as in the butterfly and the moth. Whatever their nature, their function is the same.

EXERCISE

Procure a fowl's wing feather. Draw it and name the parts. Pass your finger slowly over the vane from the end to the base. Note the barbs and how they are gently held together.

CHAPTER XV.

THE LOUSE AND THE TICK.

Most animals move about and get their food. Movement is a characteristic of animals. To obtain the kind of food that they want animals have to be active. They have to pursue their prey and avoid their enemies. But there are many animals which have become lazy, so to speak, and given up the habit of going from place to place for their food. Many such animals cling to the bodies of other animals. We have already seen how the leech feeds. When it gets a chance it sticks to the bodies of vertebrates and sucks the blood. When satisfied it lets go. The leech is a freemoving animal. But instead of killing the animal it wants for food, it attaches itself to it, but only for a short time. The animal from which the blood is sucked is not killed. It is merely made to give up a little of its blood as food for the leech.

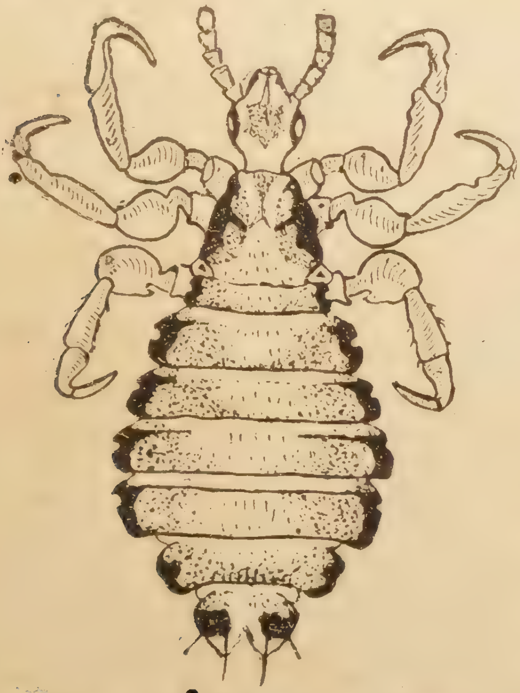


Fig. 66. The head louse. (magnified)

There are very small animals found living among the hair of mammals. They are known as *lice.* A picture of one of them is shown. It is an insect which has lost its wings. There are three pairs of legs, as in an ordinary insect. These end in small curved claws. By these claws it can cling to the hair, with great ease. The lice feed on the skin of the head. They increase in numbers, if the hair is not kept clean. The louse is a *parasite.*

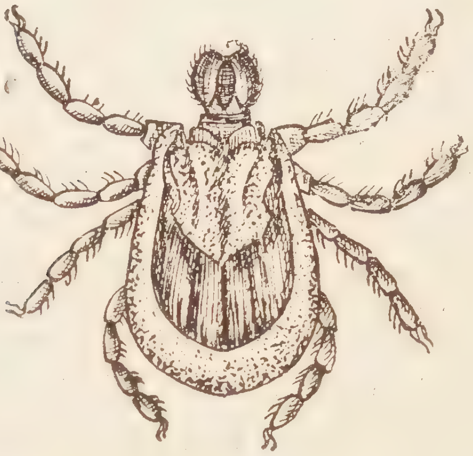


Fig. 67. Cattletick, male. (magnified.)

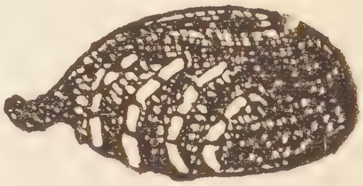


Fig. 68. Cattletick, female × 3.

Another animal which has become a parasite is to be found on the cow, the dog and other animals, amongst the hair. It is the *tick.* It is a blood sucking animal. It holds on to the body of the dog or the cow by means of the clawed legs. The mouth is adapted for sucking blood. The tick sometimes sucks so much blood that it becomes bloated and can be seen quite easily. The leech does not cling to the body of its victim or as it is called the host, permanently. The tick, the louse and the leech are all *external parasites.* The leech lets go when it has had a full meal, whereas the other two cling to the host and remain on the host.

When animals become parasitic, they generally develop organs for clinging and at the same time give up the organs of locomotion. In this respect they may be said to have become *degenerate.* In some other animals parasitism has become more pronounced. Such parasites are usually found inside the bodies, in the alimentary canal or in the blood of the hosts and not outside, as in the case of the external parasites. These are called *internal parasites.* Often they give rise to serious disease.

CHAPTER XVI.

ANIMAL COVERINGS.

Animals live under different conditions. Some live in cold countries, others in hot deserts, and still others in tropical forests. Many live in the icy waters of the northen and southern oceans. Those that live in our seas live under milder conditions. Whatever the conditions, every animal tries to withstand them and get adapted to them. Animals from Africa accustomed to a hot climate will perish, if they are transported to the extreme northern parts of Europe. Tropical animals are, no doubt, kept in the Zoos of London and Berlin but special precautions are taken to protect these animals and they do not usually breed.

Animals which prowl about in the night require greater protection than those which roam about during daytime. Every animal has thus to face special conditions of existence and should therefore be prepared to meet them. Some animals, like the birds and mammals, have a high body temperature which does not vary, whatever the temperature of the outside medium is. For example, the body temperature of a bird or a mammal in the tropics is the same as that of a bird or mammal in the coldest parts of the earth. In other words, the temperature of the body does not vary with the outside temperature. Such animals are known as *Warm blooded Animals.*

These warm blooded animals are usually provided with a non-conducting covering. In the birds the covering is in the form of feathers, in the mammals of hair. In both, the object is the same. Animals must retain their body heat. Animals like the polar bear and the seal which live in cold countries have a very thick coat of hair. Carnivorous animals like the cat, the tiger, and the lion which prowl about in the night have a good covering of hair. The sheep, which sleep in the open, develop a dense covering of wool. There are, however, animals like the buffalo and the elephant which have very little hair on their body. But they possess a very thick skin, which gives them the necessary protection from cold and heat. The whale is an exception. It lives in very cold seas. It has no covering of hair. It has, however, a thick layer of fat under the skin called *blubber*, which keeps the body warm.

Birds lead a life exposed to the sun, wind, and rain and therefore they should have a very efficient protection. This is provided for by a set of closely arranged feathers. Some of them are long and arranged on the wings and tail. These *Wing* and *Tail feathers* are used in flight. Other feathers give shape to the bird and are known as *Contour feathers.* In amongst them are soft small feathers called *Down feathers*, which keep the body warm.

All other animals are *Cold blooded.* The earthworm, butterfly, the crab, fish, frog, lizard, and turtle are all of this kind. The temperature of the blood is almost the same as the temperature of the water or air in which they live, and it varies with that of the outside. Many cold blooded animals in Russia, Siberia and North Canada are frozen during winter. But, when warm conditions return, they are warmed into life. It follows therefore, that the cold blooded animals suffer very much, due to the change of weather. In tropical countries, animals such as the snail, accustomed to moist conditions, withdraw into a shell, close the mouth with a quantity of slime preventing evaporation, and pass into a period of sleep, when the weather becomes hot and dry.

In cold countries, the bear and the fox also go into a period of winter sleep and this is called *Hibernation.* In hot countries, many animals go into a period of rest. Some fishes bury themselves in the bottom of the tank during hot weather and revive only when the rains come. During this time, there is very little activity and there is not much need for food.

Cold blooded animals have different coverings. These are protective rather than heat preserving. The snail and similar animals have a shell into which they can retreat. The cockroach, crab and the centipede have all a horny covering. This can be changed from time to time. Many of us have seen the cast off scaly coat of snakes. When a snake *grows*, it sheds its skin. The same thing happens in the crab and the other animals with a horny covering. The object is to provide successive coverings of suitable size for the *growing* body. It is very much like a growing boy getting a new and bigger coat, when the old coat becomes much too small.

The porcupine has a covering of long spines. In amongst these, there are rough hairs. The spines protect it from enemies. They can be made to stand erect, when no animal dare attack it. The South Indian anteater has a different covering. Its body is covered with a number of scales which are different from those of the fish. They are formed by the union of a number of hairs. The anteater has the habit of rolling itself into a ball, when frightened. In this condition, the scales form an efficient protection. The ant eater feeds on ants.

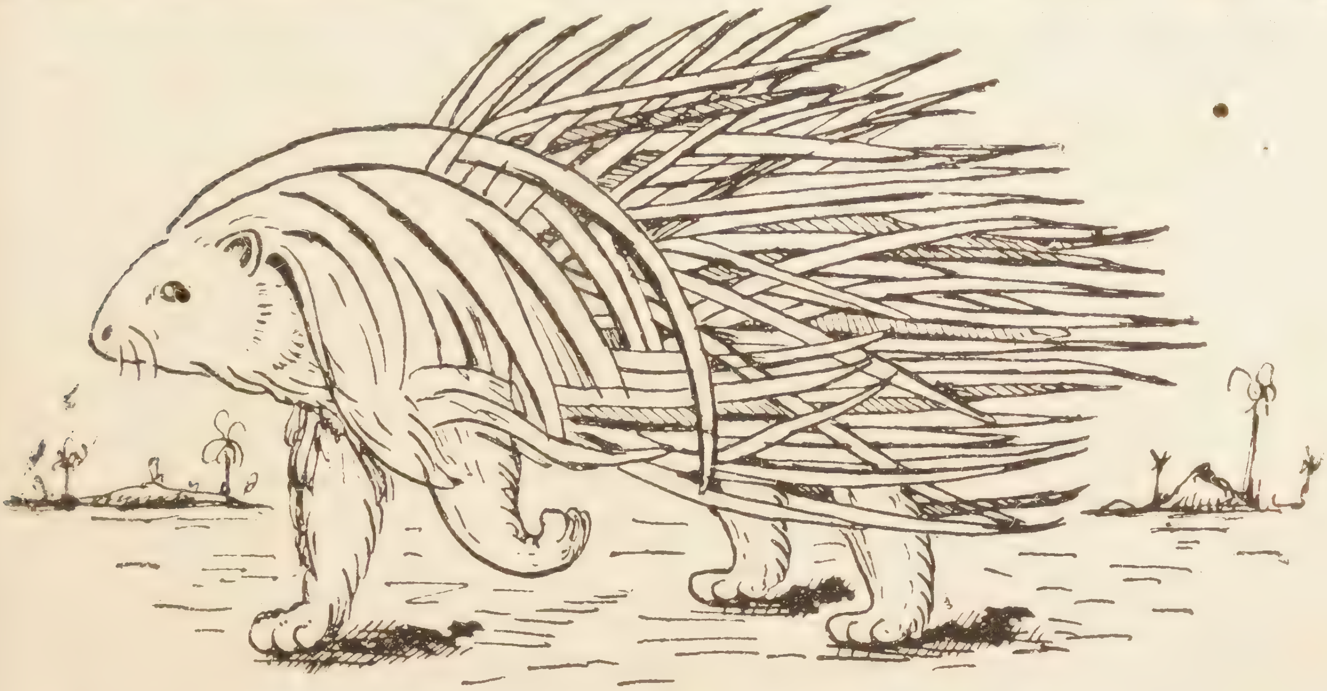


Fig. 69. A porcupine.

That is how it gets its name. It has a long tongue which it introduces into ant hills. Often the fierce ants crawl over the body but they cannot do any harm by biting, because of the scaly covering.

The tortoise is a slow animal. Its only method of

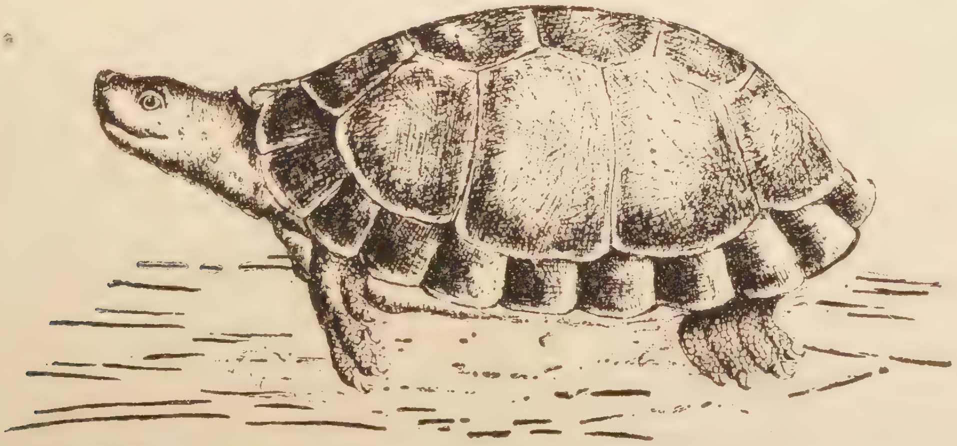
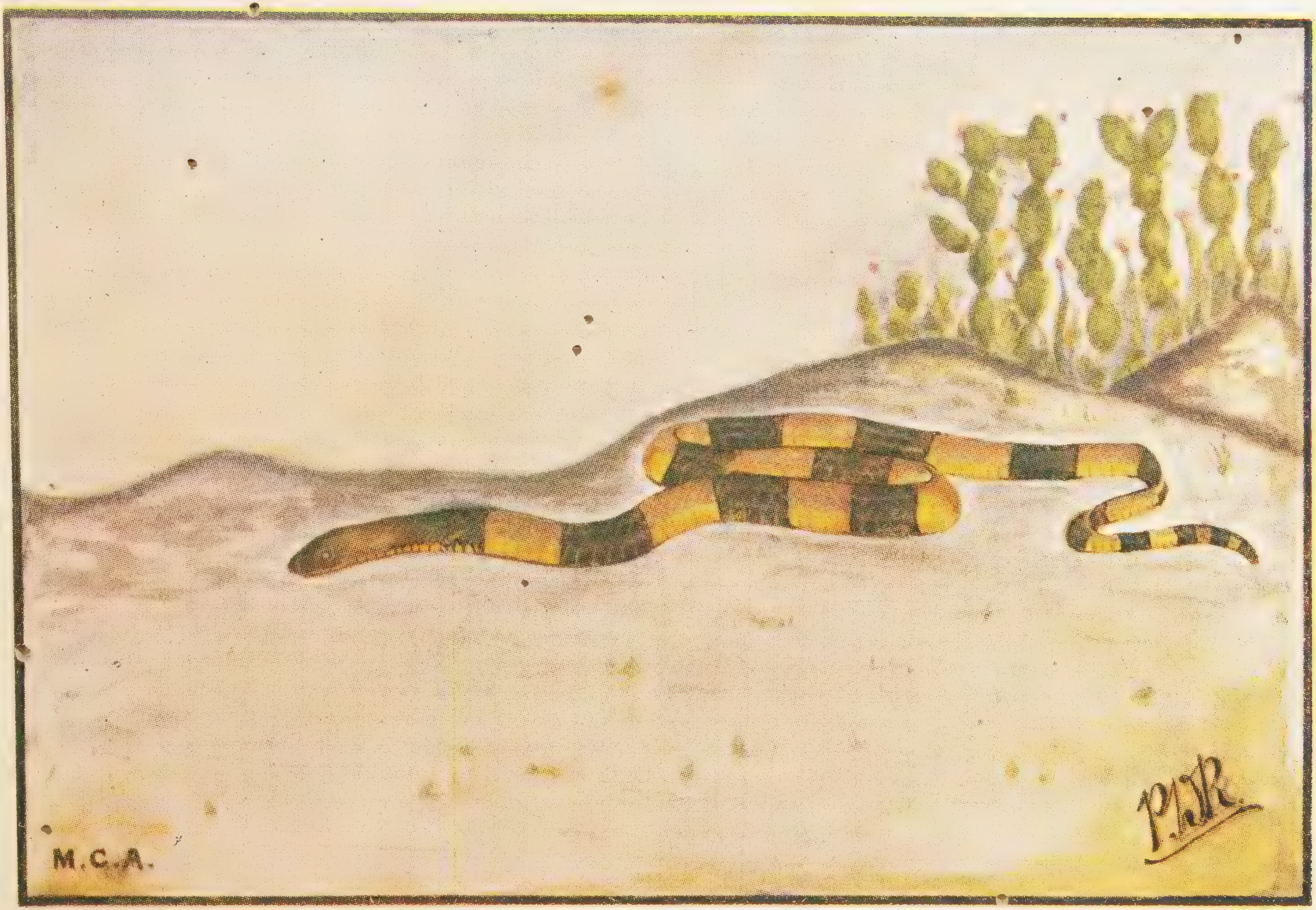


Fig. 70. A tortoise.

defence is to withdraw its head and legs into the shell, which consists of a number of bones united together. The turtle is a near relation of the tortoise but it lives in water. It is also provided with a shell. The head and the paddle like limbs can also be drawn into the 'shell.'



BANDED KRAIT *illustrating warning colouration.*

CHAPTER XVII.

COLOURATION.

In nature, animals live in intimate association with their surroundings. As we have seen, they have to adjust themselves to climatic conditions. They have to live in close relationship not only with the members of their own kind but also with animals of different kinds. Think of a fish living in a tank. Each fish has to find its own food. Since there are many fish of the same kind requiring the same kind of food, this competition for food is all the more keen. In addition, fish of one kind have to compete with fish of another kind. They have also to compete for space. This competition is not confined to the fishes but affects all the animals living in the water. It will therefore be seen that there is a great struggle between animals. We know that several animals prey upon other animals. The struggle therefore becomes all the more severe. All animals try to escape the attention of other animals. This may be effected in several ways.

A common method is to become inconspicuous, that is to develop a colouration similar to the surroundings. The grasshopper, which lives amongst grass, is not easily detected. The *Leaf insect*, which lives amongst leaves, escapes notice by its great resemblance to a leaf, both in form and in colour. This type of colouration is known as PROTECTIVE COLOURATION. Often amongst the leaf insects, the female alone shows this modification. Another excellent example is the *Stick insect*, of which a picture is shown. Its body is quite different from that of a leaf insect. Instead of being leaf like and flattened, it is very slender and is very much like a twig. The animal belongs to the same group as the leaf insect. It is found on branches commonly. Since the animal is found among twigs and branches, it escapes observation. It is a common behaviour of animals which are protectively coloured to escape notice by remaining perfectly motionless, when they are discovered. Many animals sham death when discovered. Several dangerous animals are protectively coloured in order to approach their victims with greater ease. The tiger is practically invisible amongst the reeds and grass. The praying mantis is another example. This is protection for aggression.

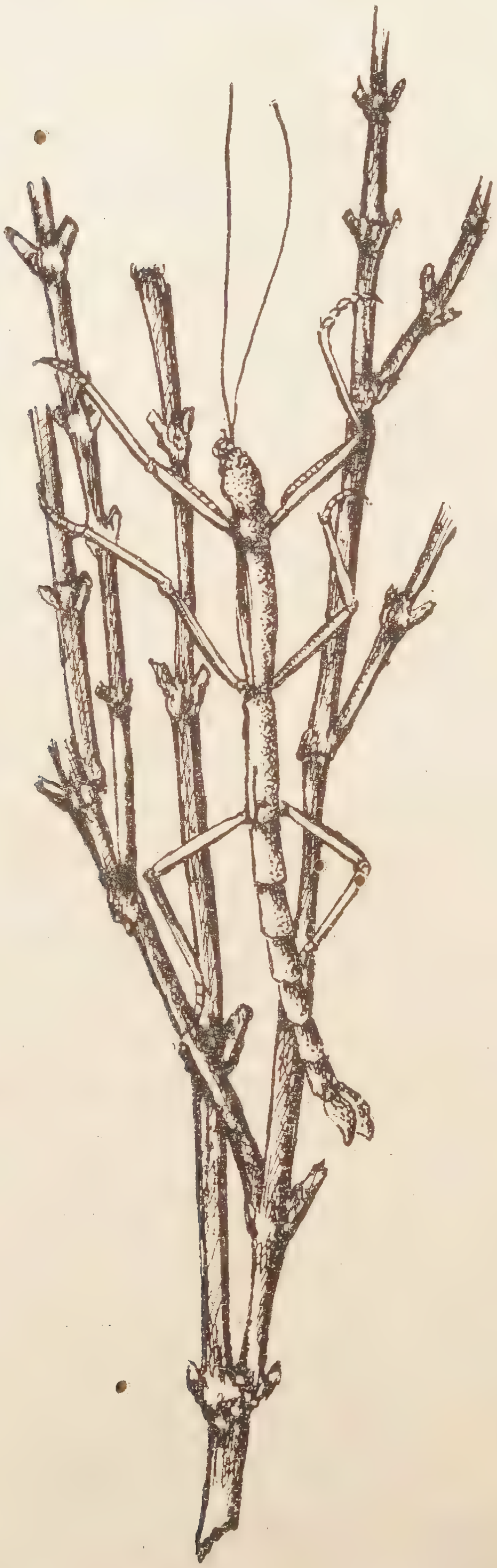


Fig. 72. A stick insect on a dry twig.

It is advantageous for a non-poisonous snake to imitate a poisonous one and thereby escape the attacks of enemies. A boy, who cannot fight, often succeeds in creating an impression that he is a great boxer. He adopts now and then a fighting pose. This procures him certain amount of respect. He is not molested. The common pond snake possessing keeled scales when frightened, raises its head and hisses like a cobra.

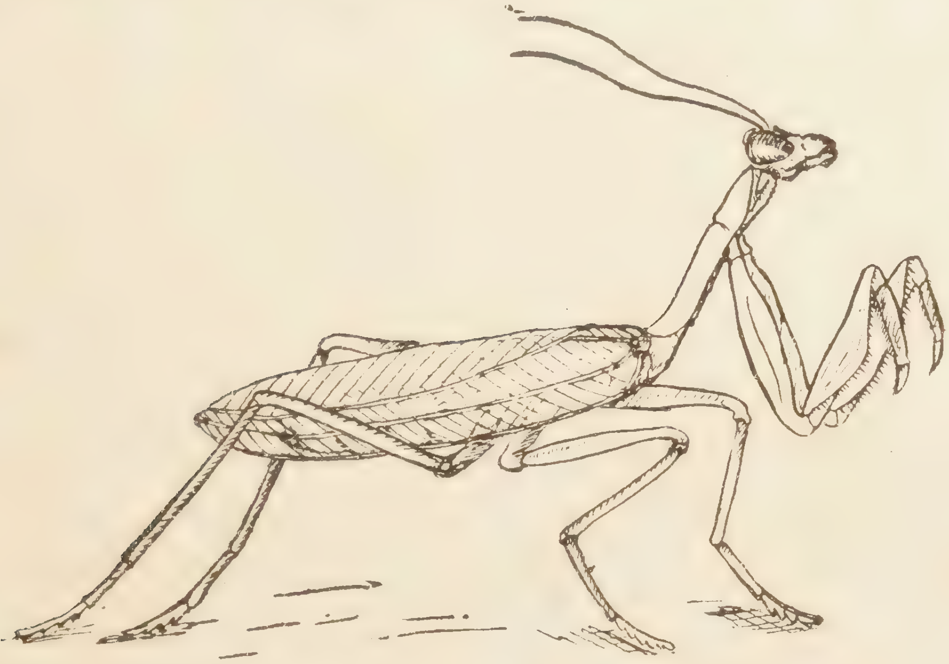


Fig. 73. Praying mantis. Note the front legs.

Here, a perfectly harmless snake produces on its enemies an impression that it is poisonous. This imitation of a harmless creature either in colour or in attitude of a dangerous animal is known as MIMICRY.

Better examples of mimicry are known amongst the butterflies. In South India we have two forms of swallowtail butterflies showing this phenomenon. The caterpillar of one of these feeds on the leaf of the poisonous plant Aristolochia. The butterfly, into which the larva develops, is bitter to the taste, and birds have learnt to recognise it by the special colour pattern it possesses and leave it alone. Another swallowtail butterfly, which is sweet to the taste, imitates the colour of the former and escapes from its enemies by producing an impression that it also is bitter.

Colouration has, at times, another meaning. It serves as an advertisement. Many animals like the yellow banded krait and the wasp are brightly coloured. The colouration is so conspicuous that it is very difficult not to notice it. The significance here is quite different. The Banded Krait is a dangerous animal. It is highly poisonous. The snake proclaims this character by its conspicuous colour. Its enemies will easily see it and experience has taught them that meddling with a creature of this colour pattern is attended with danger.

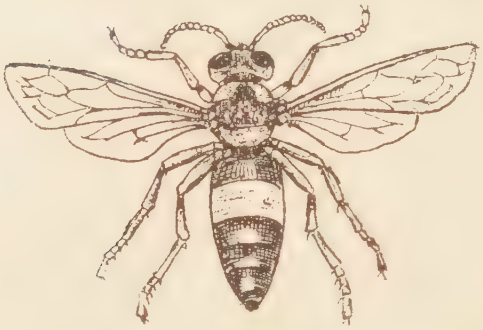


Fig. 74. The common yellow banded wasp.

The wasp, that often comes into our houses with a caterpillar as food for the young, is another example. It has a yellow banded abdomen. The sting of the wasp is very painful and various animals have learnt to associate this colour with the unpleasant results of meddling with it. This kind of colouration, which proclaims the dangerous nature of the possessor, is called WARNING COLOURATION and is very common.

The cobra is another instance. When disturbed, it raises its head, expands its hood, and makes the spectacle mark visible. In this manner, it gives full warning, so to speak, to the intruder that serious consequences will follow if interfered with. The hissing is an additional reminder to those that would interfere with the cobra.

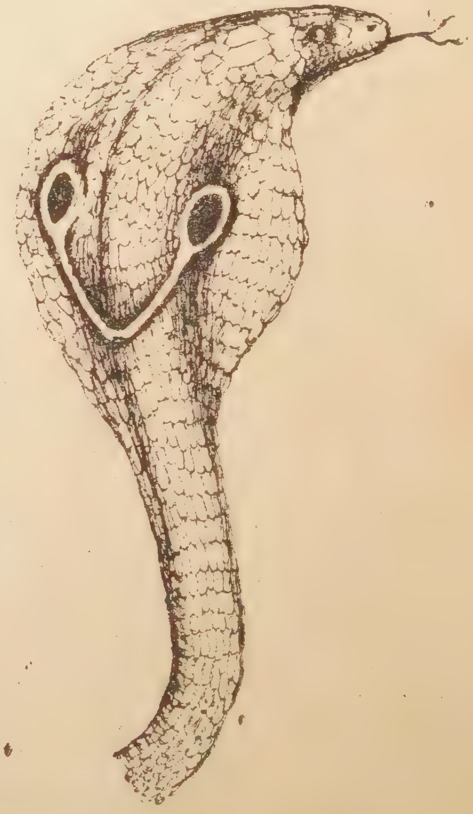


Fig. 75. Hood of cobra. Note spectacles mark.

Colour change.—There are animals which can change their colour. This often happens when the animal leaves one kind of surroundings and goes into another. The chamaeleon is a good example. In green leafy surroundings, it is green. If you take it to a different place with a sandy background, it slowly changes its colour and comes to resemble, in a general manner, the ground colour.

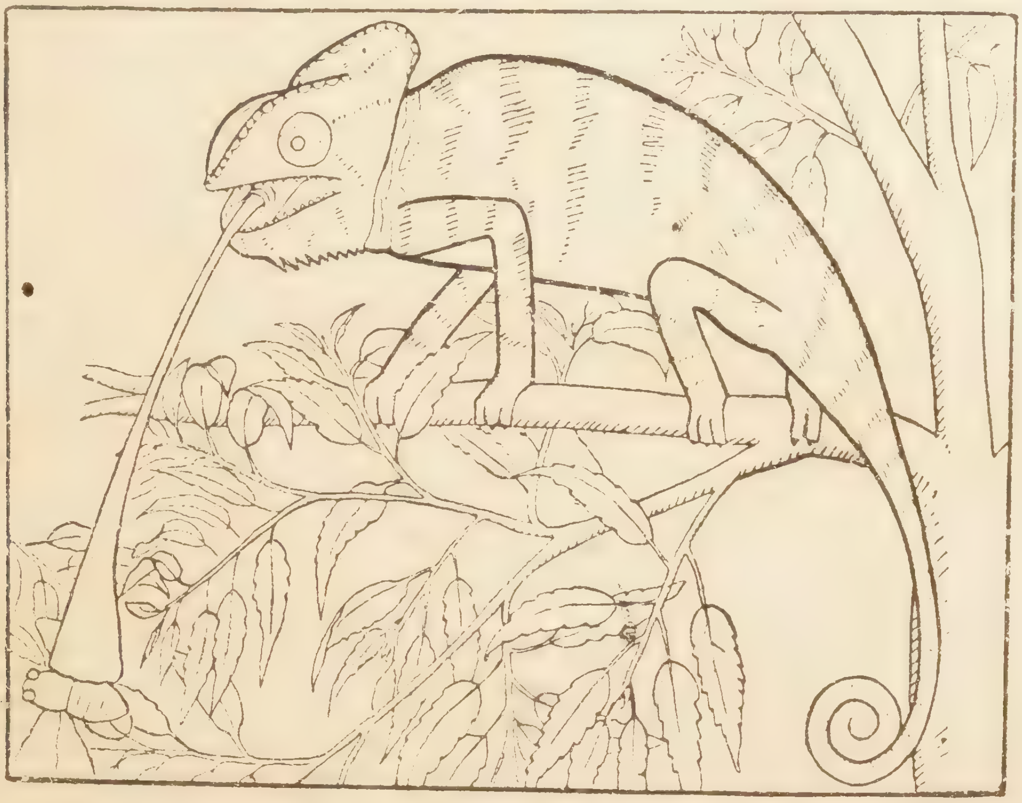


Fig. 76. The chamaeleon showing the tongue in action.

There are animals which change their colour with the season. Such animals occur in cold countries The *Arctic fox* is perfectly white when the snow covers the land in winter and the country is all white. In the spring and summer when the snow melts away, the white colour gives way to a brown. Often, birds change colour. It is usually the male bird that does so. The beautiful *Fly catcher* is an instance of this kind. But the change is during the breeding season.

There is yet another meaning which can be given to colouration. All of us know that amongst birds the males are more brightly and attractively coloured than the females. The cock differs from the hen. The peacock with its crest and its beautiful tail is totally different from the pea-hen. The male Koil is jet black in colour whereas the female is mottled. The male blood sucker, when full grown, has a crimson throat (and hence the name) while the female has no such distinction. The male of the common jumping house spider is differently and more attractively coloured than the female. This difference in colour between the male and the female is known as SEXUAL COLOURATION and is particularly common among birds.

EXERCISE.

Get into the habit of walking out to the fields and observing things for yourselves. The morning time is the best time to do so. You are sure to come across the stick insect and the praying mantis in your rambles. When you do so, observe how well they are adapted to their surroundings, both by their shape and colour.

CHAPTER XVIII.

DEFENCE AND OFFENCE.

We have seen that some animals avoid notice by their special colouration, and also animals which proclaim their character by their colour. This is really a method

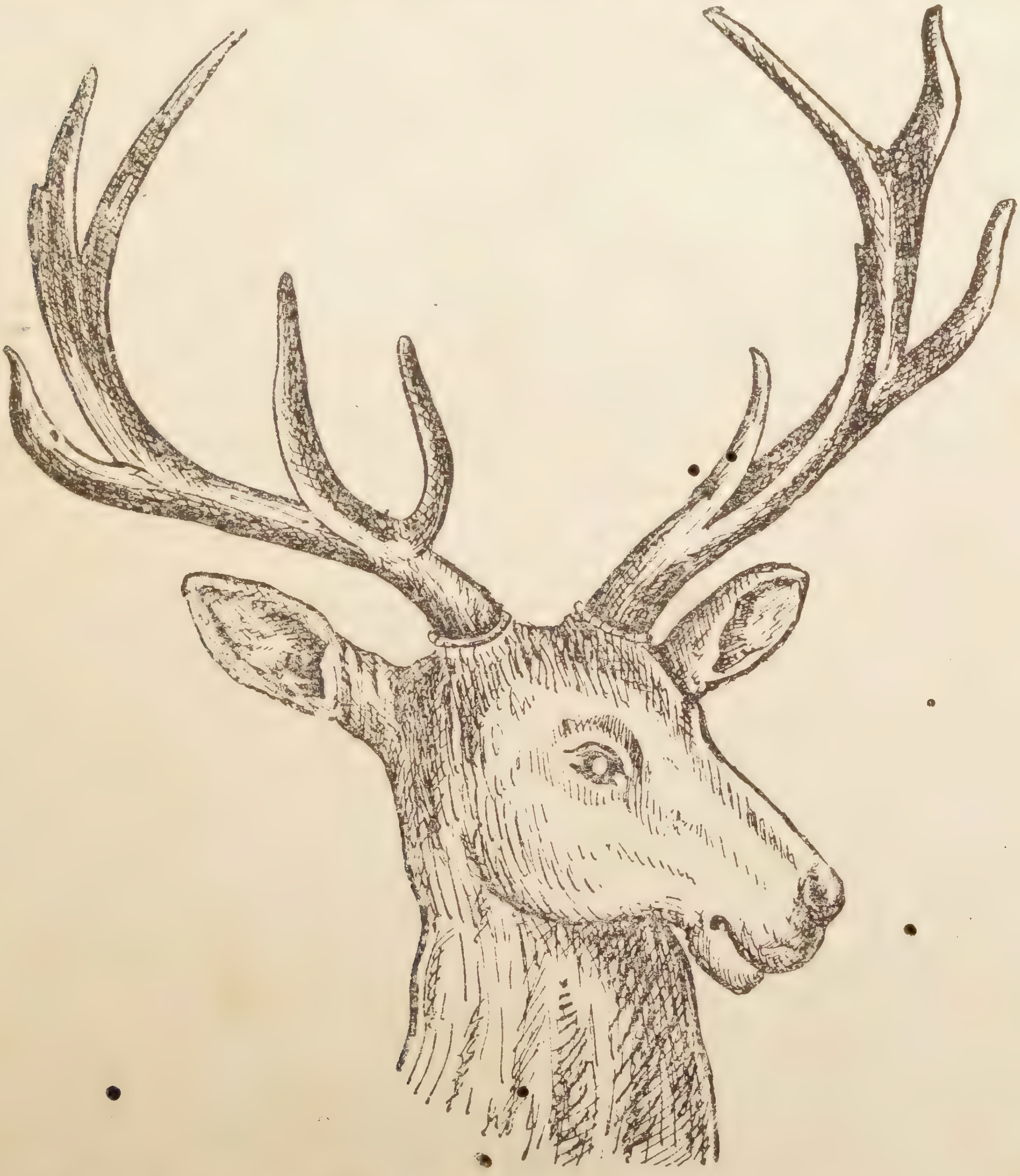


Fig. 77. Antlers of a stag for active defence and offence.

of defence. There are other ways by which animals passively defend themselves. The caterpillar has a very soft body and can easily be injured. The insect eating birds are always in search of them. Some caterpillars, being green, escape notice. Some others develop hairy processes on the body which are either simple or branched. Hairy caterpillars are usually left alone. Many of these have irritating hairs. They are avoided.

Caterpillars are too weak to defend themselves actively. The deer, the bison, and other animals, when irritated, defend themselves by their horns. In the male deer, the horns are usually branched and take the form of antlers. During certain times of the year the antlers are used for fighting with each other. Then they are shed and another pair grown next year. The bison and the sheep do not possess branched horns and they are not shed. They are present in both sexes. The spines of the globe fish form an efficient protection.

The scorpion, the wasp, the centipede, the cobra, the viper, the krait and the sea snake are all poisonous. The venomous snakes have a pair of poison glands in their upper jaw, at the angle of the mouth. A small tube or duct leads forwards from each gland and conducts the poison to the poison fang which is grooved on one side or is hollow with an opening at the tip. In either case, the poison flows along the groove or through the fang into the wound caused by the bite. When the poison mixes with the blood, it takes rapid effect

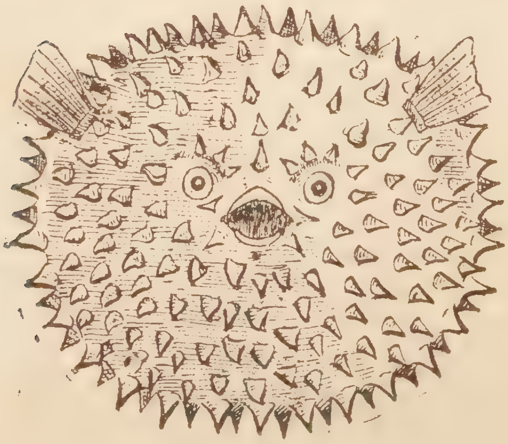


Fig. 78. A globe fish bristling with spines for passive defence.

and if a full dose of poison has been introduced, it is in most cases sufficient to kill the animal. Most animals have learned to associate the snakes with their poisonous nature and leave them alone. The venom of the cobra differs in its action from that of the viper. The former acts on the nervous system whereas the latter affects the heart and the blood.

The scorpion carries its poison gland at the end of its tail, as shown in the picture. There are two glands and

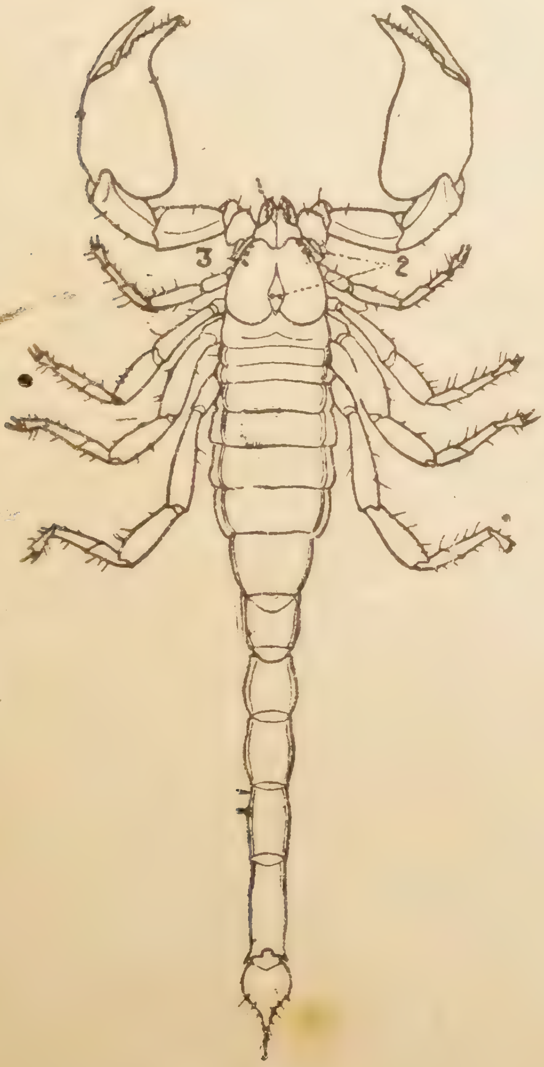


Fig. 79. Dorsal side of scorpion. 1. chelicera; 2. median eyes; 3. lateral eyes.

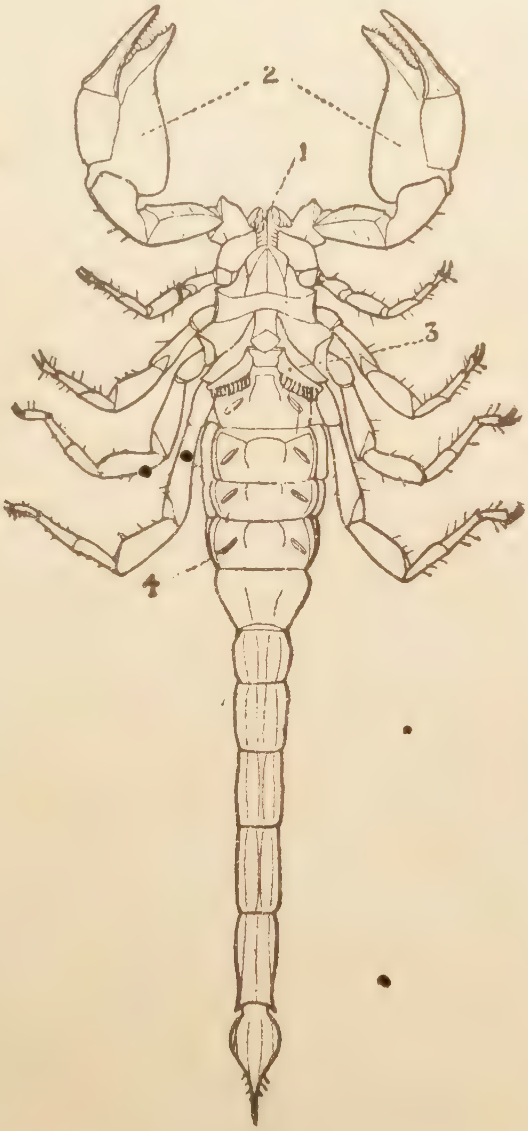


Fig. 80. Ventral view of scorpion. 1. chelicera; 2. pedipalp; 3. pectine 4. stigmata.

the ducts of these glands open at the end of a strong spine. The poison causes intense pain. Scorpions are fond of cockroaches and other small insects. They *suck* the body juices of their victims and cannot take solid food. The victim is caught by the two strong pincer-like legs and it is stung by the sting. This kills these small animals. When the prey ceases to struggle, the scorpion sucks the body juices and leaves the empty case behind.

Spiders and centipedes have poisonous claws which are placed on either side of the mouth. Each claw has a poison gland in it. The poison first paralyses and then kills the victim. The spider, like the scorpion, sucks its victims, but the centipede eats the animal it has killed.

CHAPTER XIX.

MOSQUITO.

Mosquitoes are troublesome animals. We are all familiar with them. They come in their thousands and bite us and make sleep impossible. They are a nuisance in every way. They are known to introduce many kinds of diseases into us. They spread malaria and elephantiasis. They should be exterminated. We shall now study their life history.

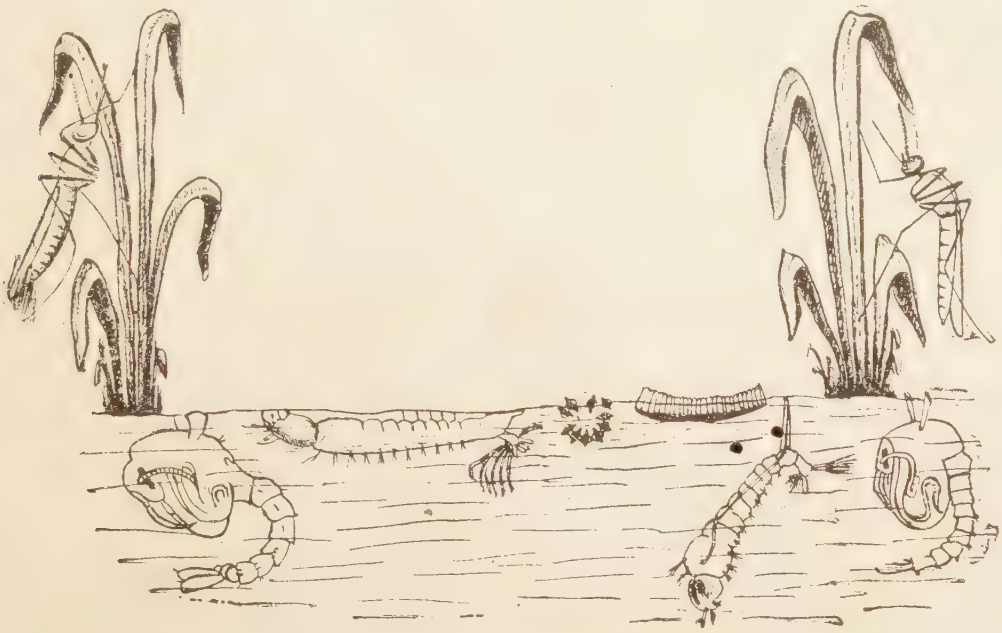


Fig. 81. Life history of the mosquito; left, malarial mosquito; right, filarial mosquito.

If you take a little water from a stagnant pool and examine it with a magnifying glass, you will see a large number of eggs of the mosquito. They occur in clusters and float easily. Each egg has one end slightly broader than the other. A female mosquito can lay hundreds of these eggs at a time. The eggs are laid only in water. Out of them, a few days after, active larvæ come out.

The larva possesses a very large head followed by a worm like boby, which is ringed. On either wide of the mouth there are brush-like organs which sweep all kinds of decaying matter into the mouth. It is on material like this, that the larva feeds. The larvae wriggle about in water, feed and grow, and come to the surface to breathe. The larva of the mosquito that spreads elephantiasis hangs head downwards. The tail is forked. At the end of one of the branches, there is a hole through which air is taken into the body for breathing.

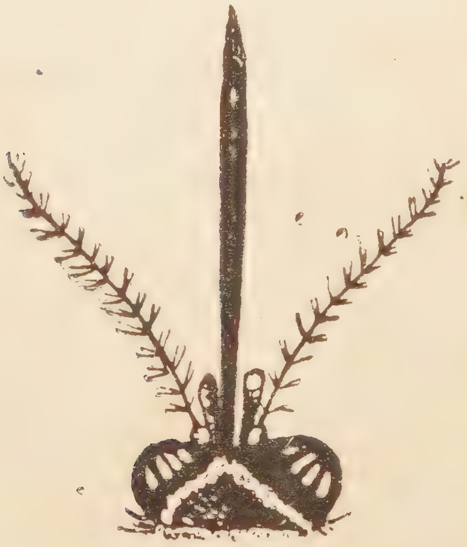


Fig. 82. Head of mosquito.

After a few days, the larva changes into another shape and this stage is called the pupal stage. The pupa differs from the active larva in that it is inert. The head portion is not distinct. The front end of the body is very much swollen and the rest of the body is shortened. Air enters the body through two trumpet-like structures which are thrust above the surface of the water. After a few days, the surface of the pupa bursts open and the fully developed mosquito comes out and flies off. The male mosquito is harmless. The head of a female mosquito is shown in the picture. The mouth is drawn out into a tube. Inside the mouth, there are several needle like piercing structures. The mosquito sits on a suitable spot on our skin and the end of the tube is planted against the skin. The needle like structures now pierce the skin. A wound is made. Into the wound, the mosquito introduces a small quantity of saliva which prevents the blood from clotting. Along with this a number of disease causing parasites are also introduced into the blood. From the wound, blood is sucked. After a meal the mosquito flies away.

Mosquitoes are of various kinds. Two of them are of importance to us. The malaria carrying mosquito is a species of Anopheles. It can easily be recognised by the way it sits. It holds its body *slanting* to the surface on which it sits. The other kind is a species of Culex and spreads elephantiasis. It sits *parallel* to the resting surface. You can see the different resting attitudes in the picture. Both have larval stages. The larva of Anopheles lies parallel to the surface of the water while that of Culex hangs head downwards. Mosquitos are dangerous animals. They must all be killed out. This can only be done by filling up all their breeding places.

In the mosquito, we have seen that the animal begins its life as an *egg* and passes through an *actively swimming larval stage* followed by *a passive pupal* stage, finally leading to the adult flying mosquito. During the larval period *solid* particles of food are taken. In the adult condition only *liquid* food is taken; blood, in the case of the female and plant juices, in the case of the male.

CHAPTER XX.

THE BUTTERFLY.

Butterflies are the most beautiful of insects. They frequent our gardens. You have already learnt something about their feeding habits. We shall now study about their life history.

A common form of butterfly is the Lemon Butterfly. It is shown in the picture. It lays its eggs on various plants such as the lime and the orange. Each egg hatches and a tiny smooth larva called the *Caterpillar* comes out.

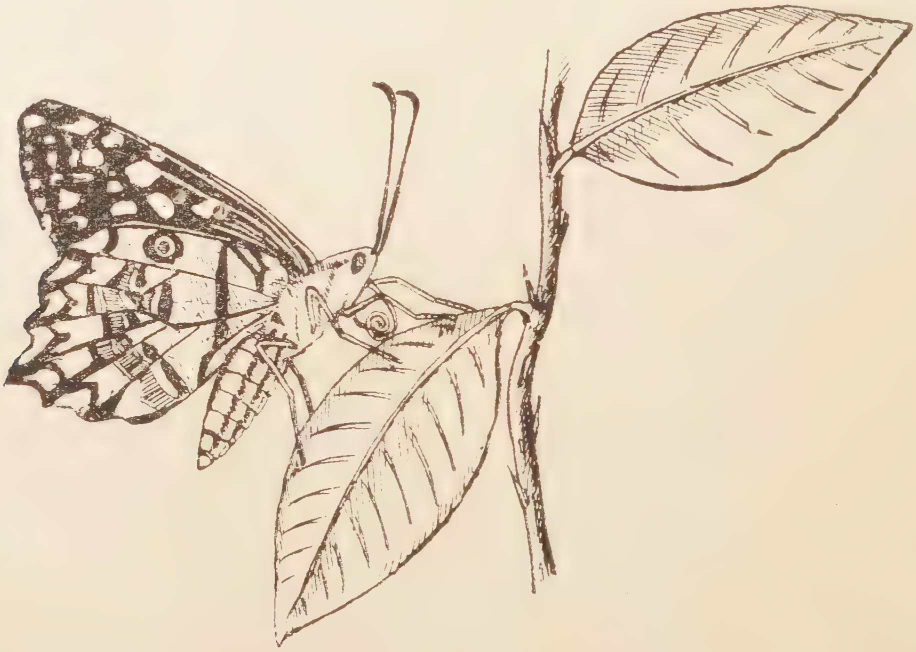


Fig. 83. Lemon butterfly.

It has a head, large eyes and mouth parts adapted for biting and chewing. Behind the head there is a ringed body. There are three pairs of jointed legs and behind these 5 or 6 pairs of sucker legs, also called false legs. Its upper surface has a white irregular blotch which makes it look like a bird's excrement. This is essentially a feeding stage. It feeds mostly on tender leaves. It is voracious and grows very much in size. It passes into the next stage, the *Chrysalis or Pupa* stage. As in the mosquito, the pupa is very inactive. Inside the pupa, several changes take place. The body parts of the butterfly are all formed now. The pupa does not feed. The outer case of the chrysalis breaks open after some time and the fully formed butterfly comes out. At first the wings are wet. When they dry up, the nectar sucking butterfly takes to its wings. The oleander butterfly is another common insect.

Like the mosquito, the butterfly starts its life as an egg. This is succeeded by an actively moving larval stage. Then the pupa or chrysalis stage follows. Finally the adult condition is attained. The larva is quite different from the adult in structure, habits, and in the

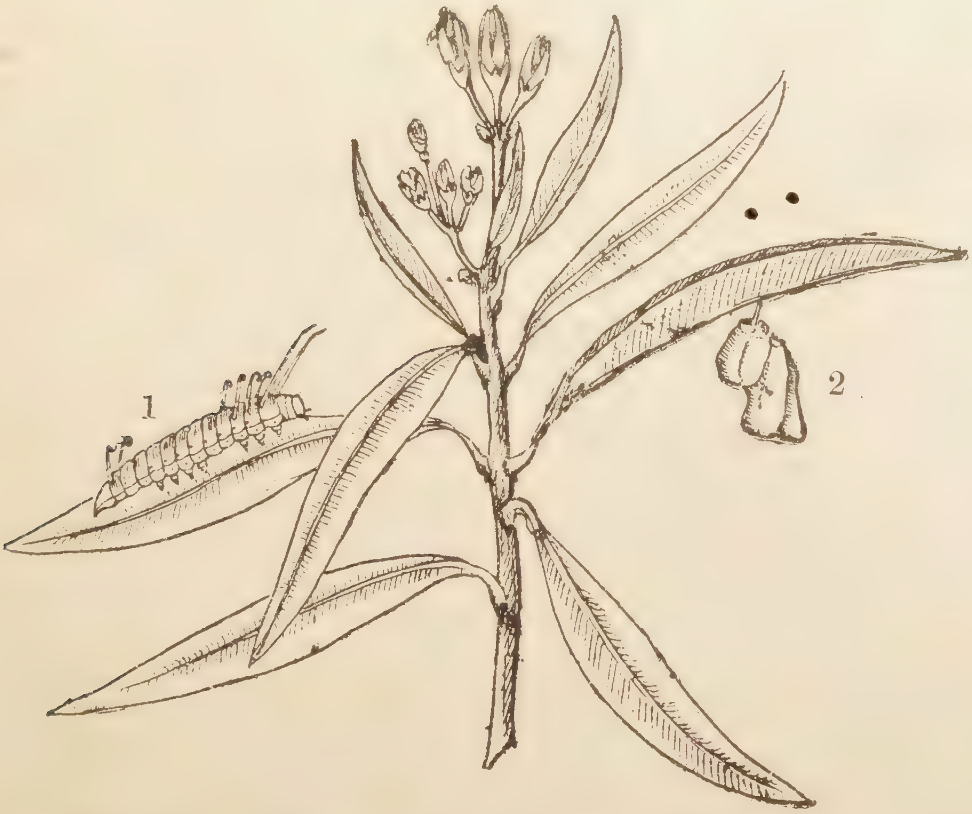


Fig. 84. The caterpillar and the chrysalis of the oleander butterfly
1. caterpillar ; 2. pupa.

nature of food. The body characters are in accordance with the habits at the different stages of the life history.

Butterflies differ slightly from moths. When a butterfly sits, it folds its wings over its back. The feelers are club shaped. They roam about during daytime, visiting flowers. Moths are nocturnal. Their feelers are feather shaped and when they rest the wings are extended sideways. But their life histories are similar. Butterflies and moths, when fully grown, are rather useful animals. They visit flowers and, in doing so, transfer pollen grains from flower to flower and thus make them grow into fruits, by fertilising them.

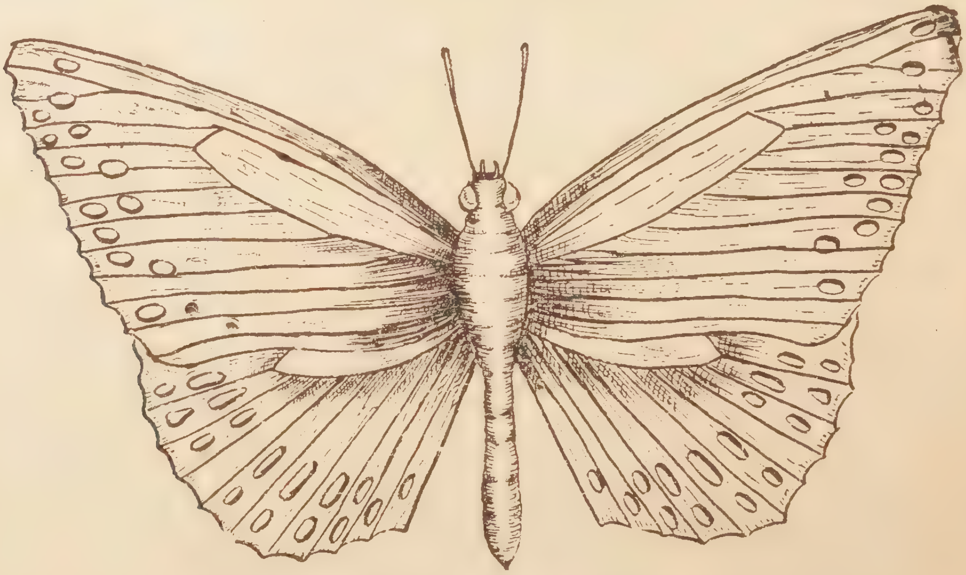


Fig. 85. The oleander butterfly.

In the caterpillar stage they do great harm. They eat away the leaves of useful plants. Often, seed grains are destroyed by moths. But the mulberry silk moth is very useful to man. The larvæ which emerge from the eggs are given the mulberry plant as food. Then they construct cocoons of silk by producing the silk thread from their salivary glands and then winding it round and round. They are not allowed to come out, for, if they do so, the continuous thread of silk forming the cocoons will be spoilt. So the cocoons are collected and the larvæ inside are killed by being placed in boiling water. Then the thread of the cocoons is reeled off, wound, and made into cloth. All the cocoons are not used in this manner.

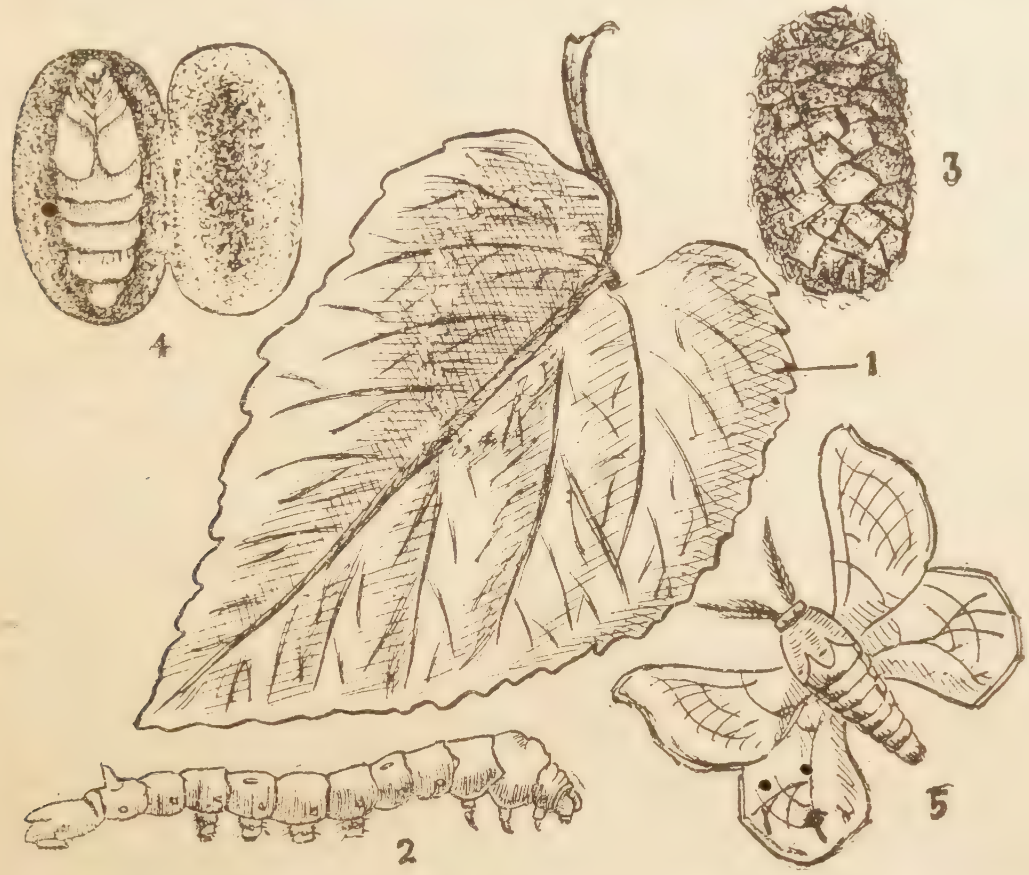


Fig. 86. The silk moth. 1. mulberry leaf; 2. caterpillar; 3. cocoon; 4. cocoon cut open to show pupa; 5. silk moth.

A few are kept as 'seed.' From these the silk moths—male and female—emerge and mate. It is curious that they do not feed. They have not even the tongue to feed with. They live for a few days only and during this time the females go on laying eggs. Having performed *this all important function of leaving progeny*, they die.

CHAPTER XXI.

THE FROG.

You know something about the frog. It is an air breather. It spends most of its time in water. Often, it comes out, on to the shore. It is equally at home in water as well as on land. Therefore, it is called an *Amphibian*. It is well adapted to life in water. The body consists of a head, and a trunk and two pairs of limbs. Eyes are placed on the top of the head and are prominent. The nostrils are placed in front and can be closed by means of valves. When in water, the frog can float with its nostrils and eyes alone above water. This is a great advantage, as it can see and breathe at the same time. The forelimbs are short and are provided with only four fingers. The hind limbs are long and muscular and the toes are webbed. There are five toes and a small additional toe. That is why the common frog of Madras is called the six-toed frog (*Rana hexadactyla*). While in water, the skin also performs the function of respiration. When it comes on land, it assumes a squatting position. In this position, the hind limbs are folded under the body, and you can see the characteristic hump on the back of the animal. The frog is a good jumper and can clear three to four feet at each leap. That is why the hind limbs are so strong and long.

The frog lays its eggs in water. The rainy season is the time when you should look for the frog's eggs. Several of them are laid together in a jelly-like mass called the *spawn* of the frog. It is a common object in any pond during the rainy season. If a quantity of the spawn be collected and kept in a glass vessel in water with a few weeds, the eggs can be observed during their development. At the end of about ten days the eggs hatch out and very young creatures called *tadpoles* come out. They do not feed now. They are very tiny creatures, rather dark in colour, with a head, a swollen

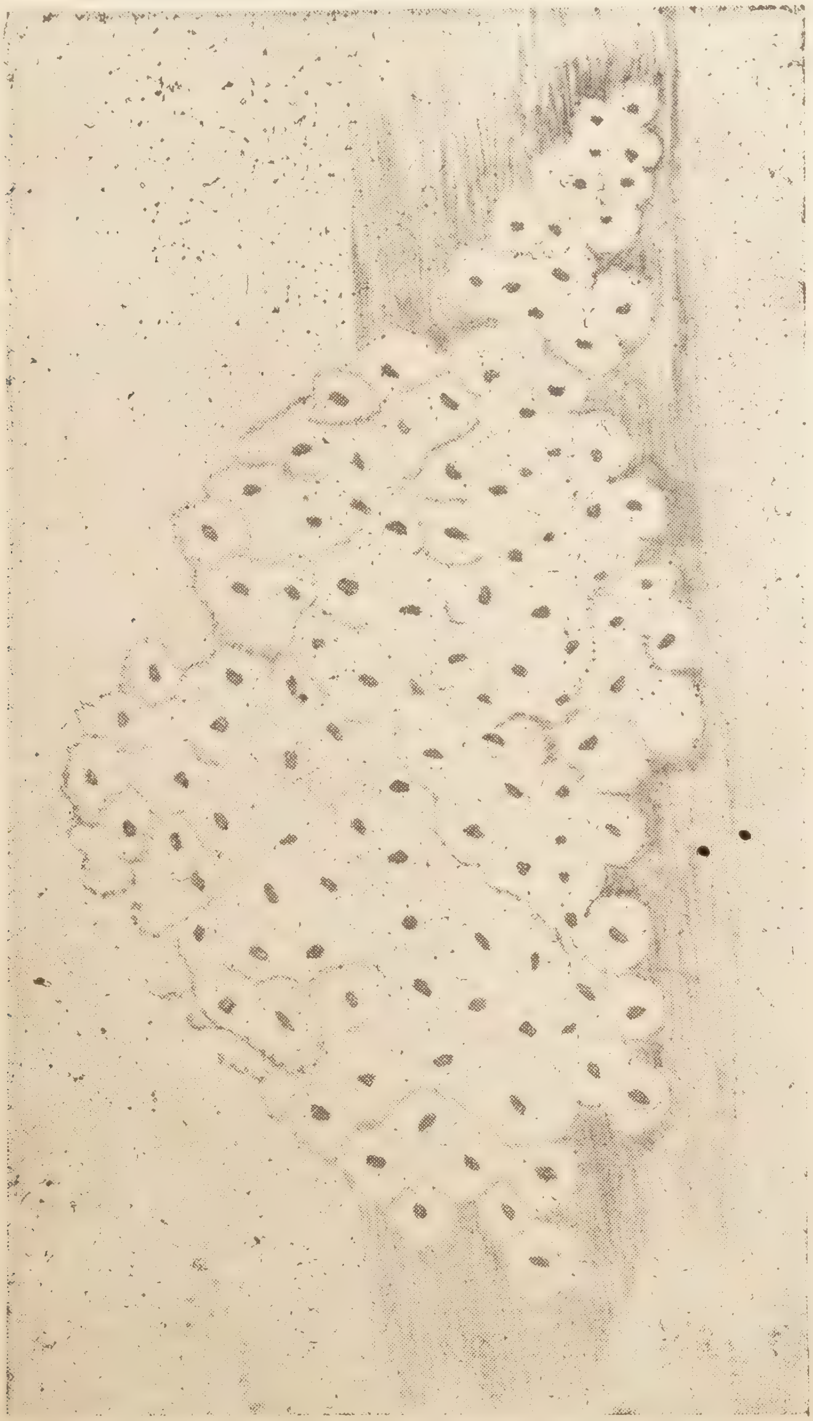


Fig. 87. Spawn of frog.

trunk and a tail. At first, they swim in the jelly for sometime; then they come out, swim in the water and attach themselves to weeds by a sucker-like organ on the chin. Soon, the mouth is developed and the tadpoles begin to feed. Fringing the mouth there are hard horny teeth with which they nibble pieces of water weeds.

Just at this time, a pair of soft processes appear behind the head, one on each side. These are the *external gills.* Two more pairs are added on and these three pairs are the organs of respiration at this stage. Now the tadpoles feed voraciously and in keeping with their vegetable feeding habit the alimentary canal lengthens out and is wound up in the form of a spiral.

Behind the external gills, four openings in the form of slits are formed on each side. These are the *gill slits.* These lead into the mouth. Inside, the gills make their appearance. They are similar to the gills of a fish. A gill cover appears on each side and encloses the slits. When these gills have formed, the external gills begin to shrink and finally disappear. The tadpole now breathes by the *internal gills.* As in the fish, the tail is the swimming organ of the tadpole. Later on, at the root of the tail, on either side, the hind limbs sprout out. This is soon followed by the appearance of the anterior limbs which sprout out just beind the head, behind the gill slits. The tadpole is now provided with a distinct head, a trunk, two pairs of limbs and a tail. Fringing the tail there is a fin. In general shape also the tadpole is like a fish. Soon, all this changes. The gill slits close. Two lungs are developed inside the body. The tadpole comes up now and then to breathe. The tail rapidly shortens and is used up and the limbs are developed. The tail finally disappears altogether and the animal uses the

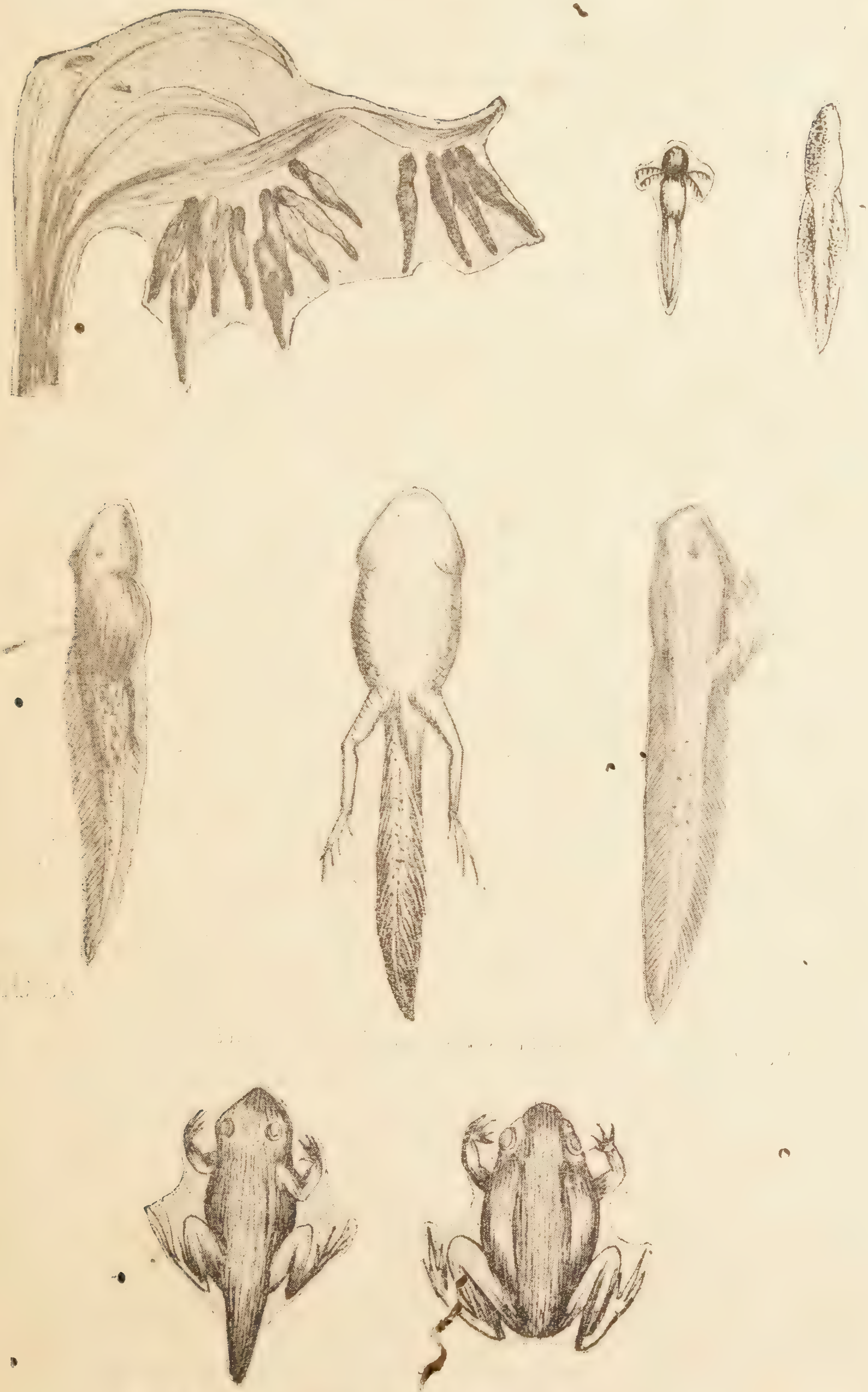


Fig. 88. Stages of frog development

limbs for locomotion. The alimentary canal shortens. A forked tongue, attached in front to the tip of the lower jaw, has developed. The tadpole ceases to feed on vegetable matter and begins to catch small insects and similar small animals. It scrambles now and then on to the land and jumps about. In fact, it has now become a small frog. All this has taken about three months.

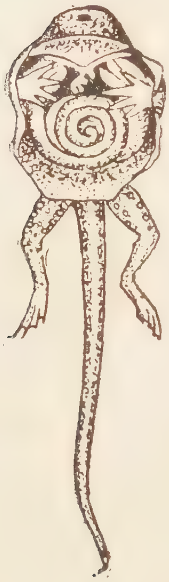


Fig. 89. Tadpole with food canal exposed.

You will notice that, as in the case of the mosquito and the butterfly, there are three definite stages. The egg stage is followed by the larval stage. The larva is the tadpole. In structure and habits, the tadpole is different from the frog. There is no pupa stage as such. The tadpole *metamorphoses* into the frog and in doing so, it gives up its gill breathing, vegetable feeding habits and changes into an air breathing carnivorous animal. These changes constitute the *metamorphosis.*

The toad is a near relative of the frog. It habitually lives on land, except when it wants to lay eggs. Its back is warty and contains glands which produce an irritating liquid. Frogs and toads are very useful animals as they destroy large numbers of harmful insects.

CHAPTER XXII.

REPRODUCTION.

Animals start their life in the form of eggs. From the egg, by gradual growth, the young one is formed which adapts itself to the conditions in which it lives, feeds, respires and grows. Of the numerous animals that live in the world, many are killed and eaten. Some die a natural death and some others die a violent death. You will see, that if all the animals are killed or die in some manner or other, there will soon be no animals left in this world. But then, before they die, they leave their children behind, and these grow, struggle against one another, and they in their turn die leaving progeny. *It may therefore be said that reproduction is a characteristic of all living animals.*

You all know, that animals generally are either male or female. It is very difficult to distinguish the male from the female in the case of the lower animals, by external characters. There are, however, others in which the males are easily distinguished from the females by certain characters. The mother animal may produce eggs, as in the case of the frog. In many cases young ones are born, as in the rabbit. Animals, which lay eggs, are said to be *Oviparous.* Most animals are oviparous. Mammals, however, with a few exceptions like the Australian Anteater and Duckbill, bring forth young ones. They are said to be *Viviparous.*

When eggs are laid, the mother often provides in the egg a quantity of food material known as yolk. When the egg is comparatively small, as in the bony fishes and the frog, the amount of yolk is small. This matter is used up by the growing egg *or embryo*

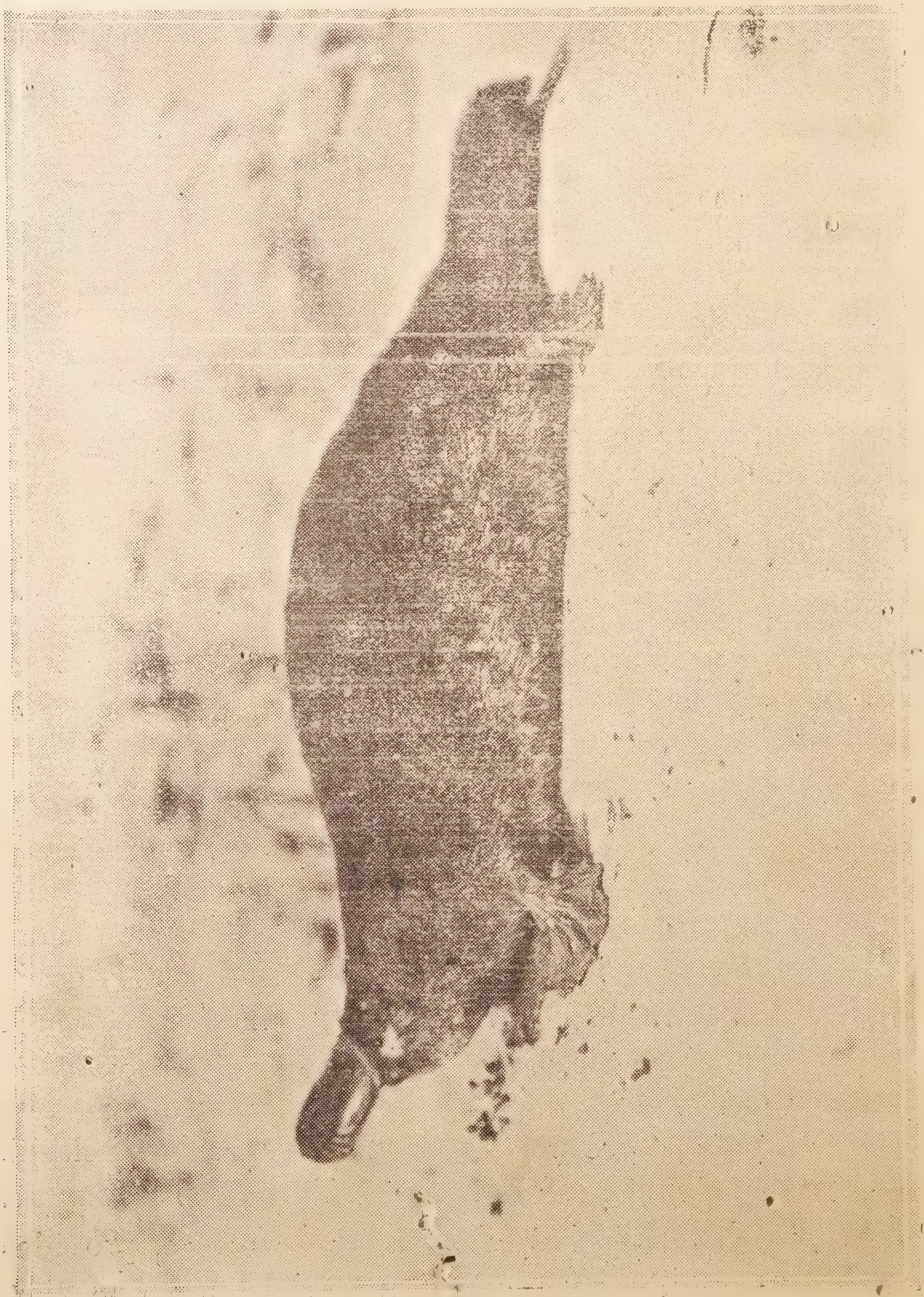


Fig. 90. The Duck bill, an egg laying mammal. *Courtesy, Australian Government Photographs.*

during the first one or two weeks. When this food is exhausted, the egg hatches out. The next stage is known as the larval stage. *The larva moves about actively and gets its own food.* The mother does not feed them at this stage. A larval or rapidly moving stage is necessary in cases where the amount of food material in the egg is small and insufficient for the entire growing period of the young one. There are other animals, like the reptiles and the birds, in which the eggs are very large. There is in them a very large quantity of yolk. Here, there is no necessity for a larval period ; for, all the development can take place at the expense of the food material *already* provided in the egg. In shape the larva is very different from the adult, as well as in the feeding habits. Oviparous animals usually produce large numbers of eggs and do not care for them. When eggs are taken care of by the parent or parents, fewer eggs are produced.

In viviparous animals like the rabbit, the young one at birth looks very much like the parent, except in size. The first part of the development has taken place inside the body of the mother. During this period the blood vessels of the young one and the mother are in very close relationship. Consequently, the nutrition taken by the mother is conveyed in an assimilated condition by the blood vessels of the mother and transmitted to the blood vessels of the young one, which grows on this nourishment thus supplied.

The duration of the first period of protected development inside the mother varies. In the rabbit, it is one month. In the dog, it is about four months and in the cow and man it is nearly ten months. The young ones are born in a helpless condition and have to be fed.

Now follows a *second* period of protection and nutrition. The milk of the mother is used for nourishing the young one which grows rapidly and becomes a full grown animal. There are thus in viviparous animals two periods of development, one inside the mother and the second outside, when the mother suckles the young.

CHAPTER XXIII.

CARE OF THE YOUNG.

We saw in the previous lesson that animals either lay eggs or bring forth young ones alive. Many animals, like the fish, lay several millions of egg. They are generally scattered in the water. Most of these are eaten by other animals and only a very few develop. It

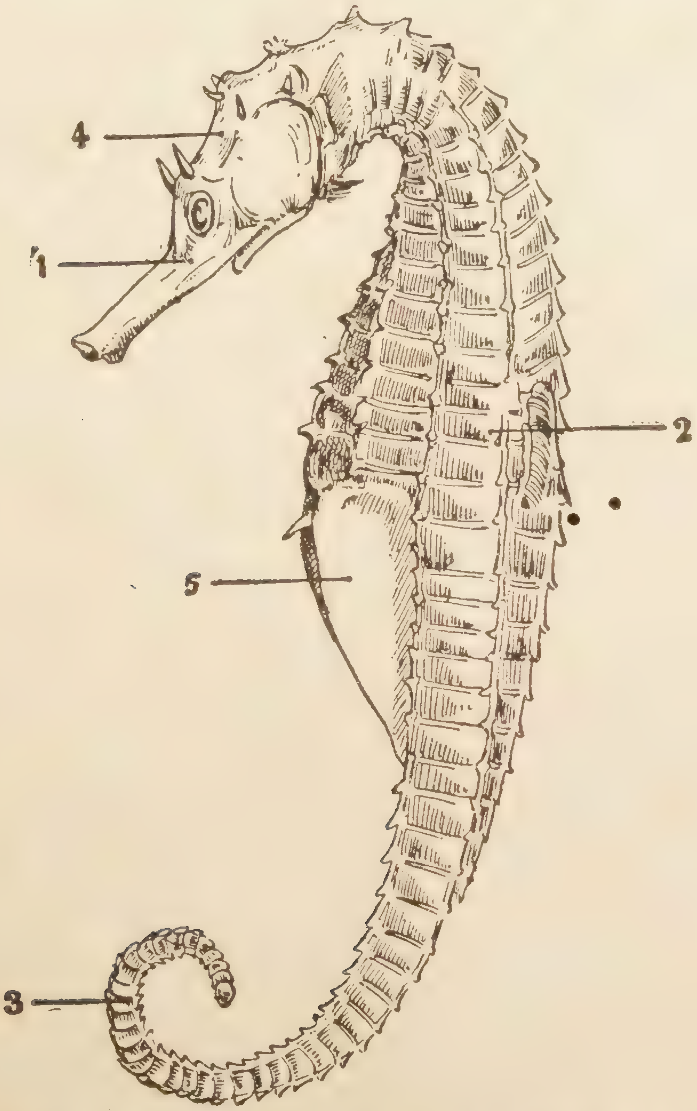


Fig. 91. A male sea horse. 1, Snout; 2, trunk; 3, tail; 4, head; 5, brood pouch.

is because there is so much of destruction of the eggs, that fish lay so many eggs, so that, *some at least may escape and grow into adults.* In viviparous forms the mother takes care of the young, protects and feeds them. There is, therefore, verylittle of destruction of the young ones. *Consequently there is no need to produce large numbers of eggs.* Production of a large number of eggs is always a great strain on the mother.

Some fish do not scatter their eggs indiscriminately. They lay them in nests and protect them in other ways. The male sea horse carries the eggs in a pouch in his abdomen where they are placed by the female. In these cases, there will not be much destruction of the eggs and so the number of eggs has also diminished. All of you are familiar with the house spider. The female, very often, carries a white round case under its body. It sometimes drops it when frightened. If you tear it

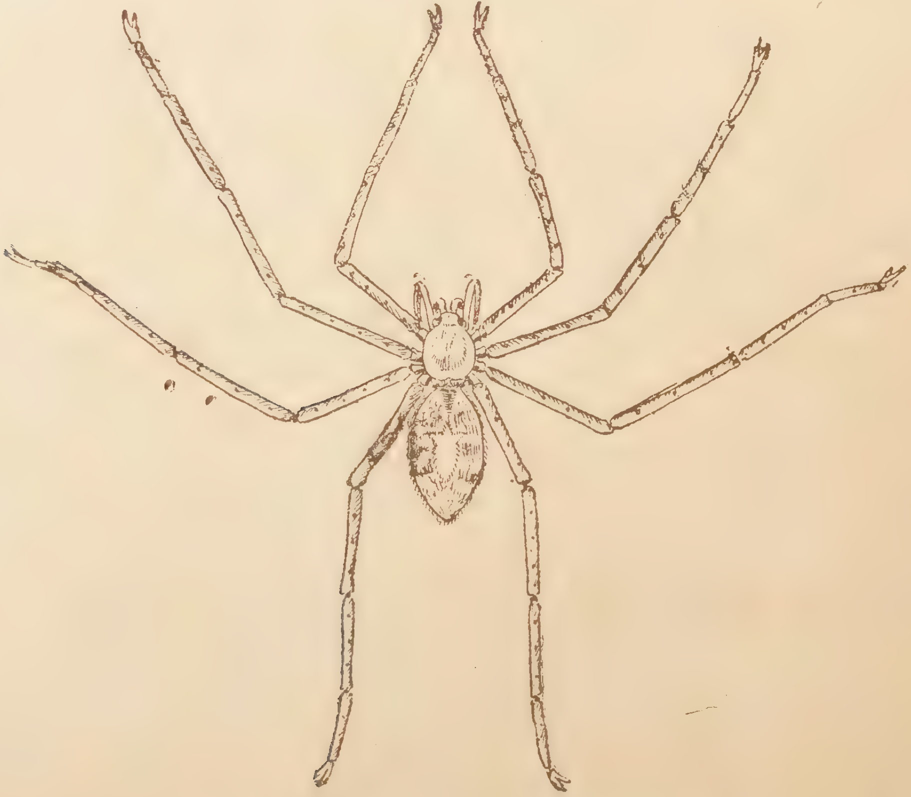


Fig. 92. A common house spider.

open, you will see inside it many minute spiders. These are all carried by the mother and taken care of.

The scorpion brings forth young ones alive, and these minute scorpions scramble on the back of the mother and till they are able to take care of themselves they are carried by the mother. There is a 'cat fish' in tanks in some parts of the country, the male of which carries in his mouth several of the eggs till they are hatched. It is said that he does not feed all this time.

Care of the young is best developed in the higher animals like the birds and mammals. Birds build nests of various kinds in which they lay their eggs. The mother and, sometimes, the father often sit on the eggs and keep

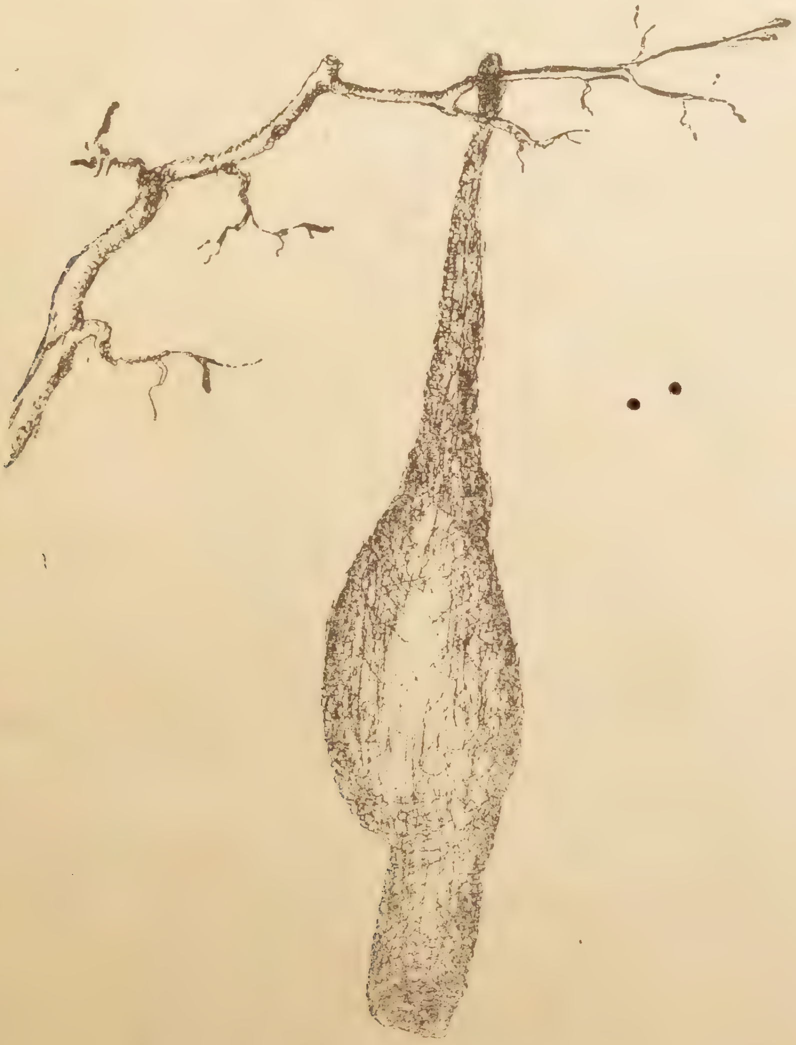


Fig. 93. Nest of weaver bird.

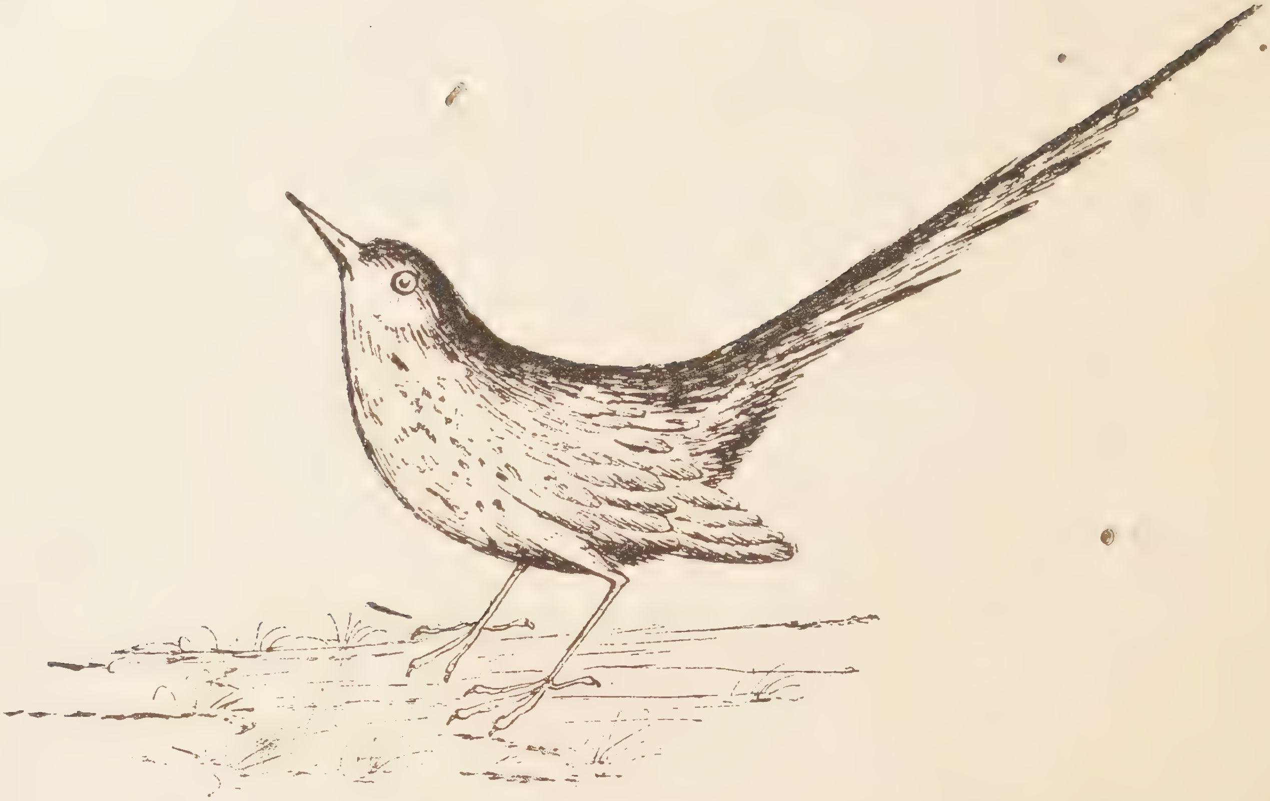


Fig. 94. A tailor bird.

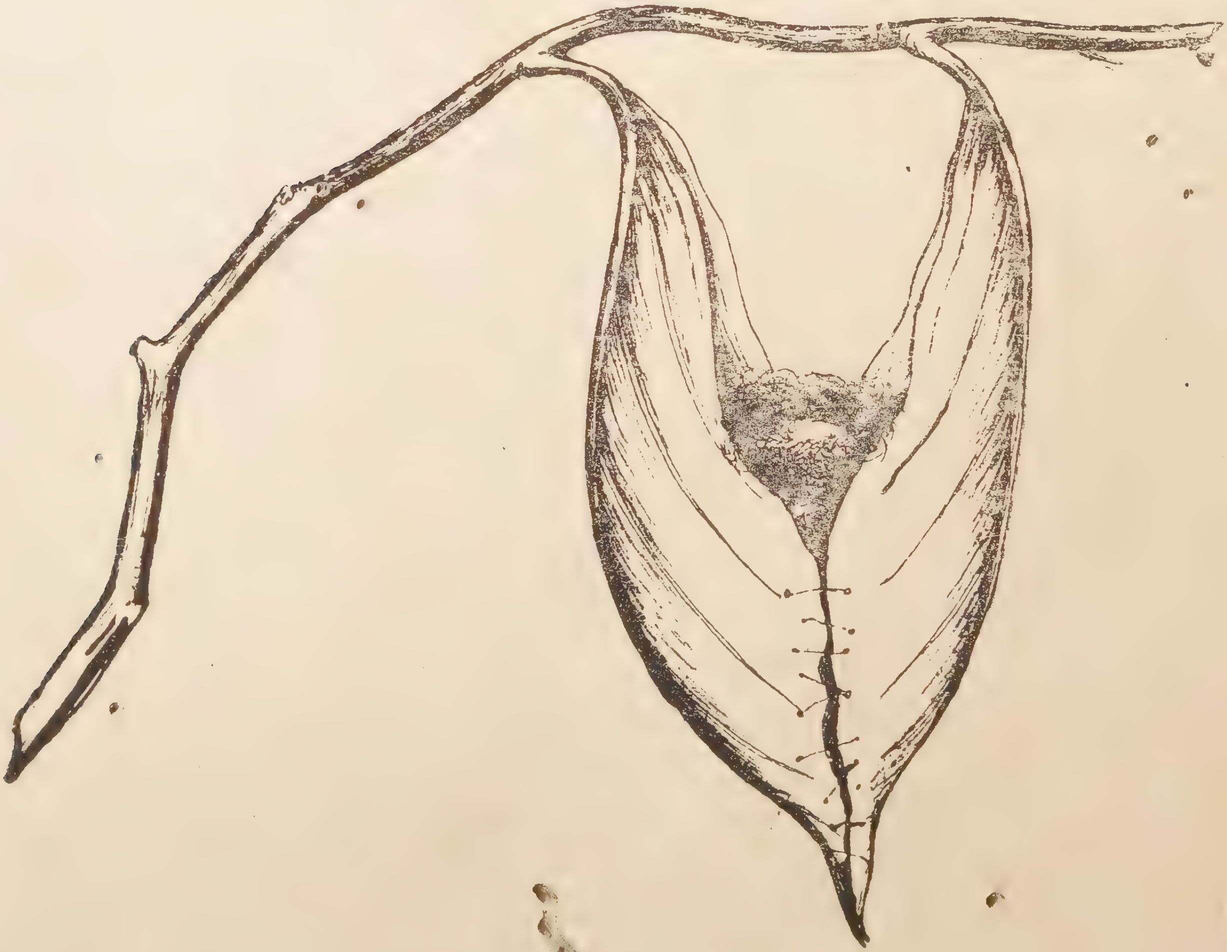


Fig. 95. Nest of tailor bird.

them warm and defend them from enemies. Unless kept warm in this manner, the eggs will not hatch. When the eggs are hatched, the father and the mother feed them till the young are able to fend for themselves. Birds also lay their eggs in holes. The coppersmith is an example of this. It bores out a hole in the trunk, or the branch of a tree, and lays its eggs there. The crow, the kite, and some other birds build their nests amongst branches of trees. The kingfishers usually lay their eggs in holes on the banks of rivers. The weaver bird constructs elaborate nests which it suspends from leaves of palm trees. The tailorbird is very clever in making nests by sewing the edges of leaves and forming a cupshaped nest.

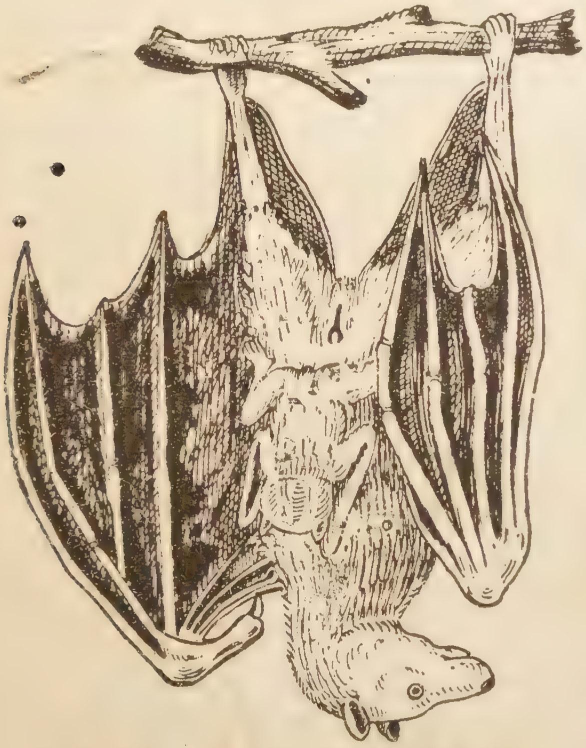


Fig. 96. A bat with Young.

The Koil is an exception. It does not take the trouble to build a nest. Watching for a suitable opportunity it steals into the nest of a crow and lays its eggs amongst those of the crow. The crow, clever as it is in other ways, is not able to distinguish its eggs from those of the intruder. With the same care and affection, it sits on all the eggs and young crows and young koils come out. At this stage, all the young ones are similar. The young of the crow, as well as those of the koil, are all fed together.

Mammals, with the exception of a few in Australia, bring forth young ones. You have all seen with what

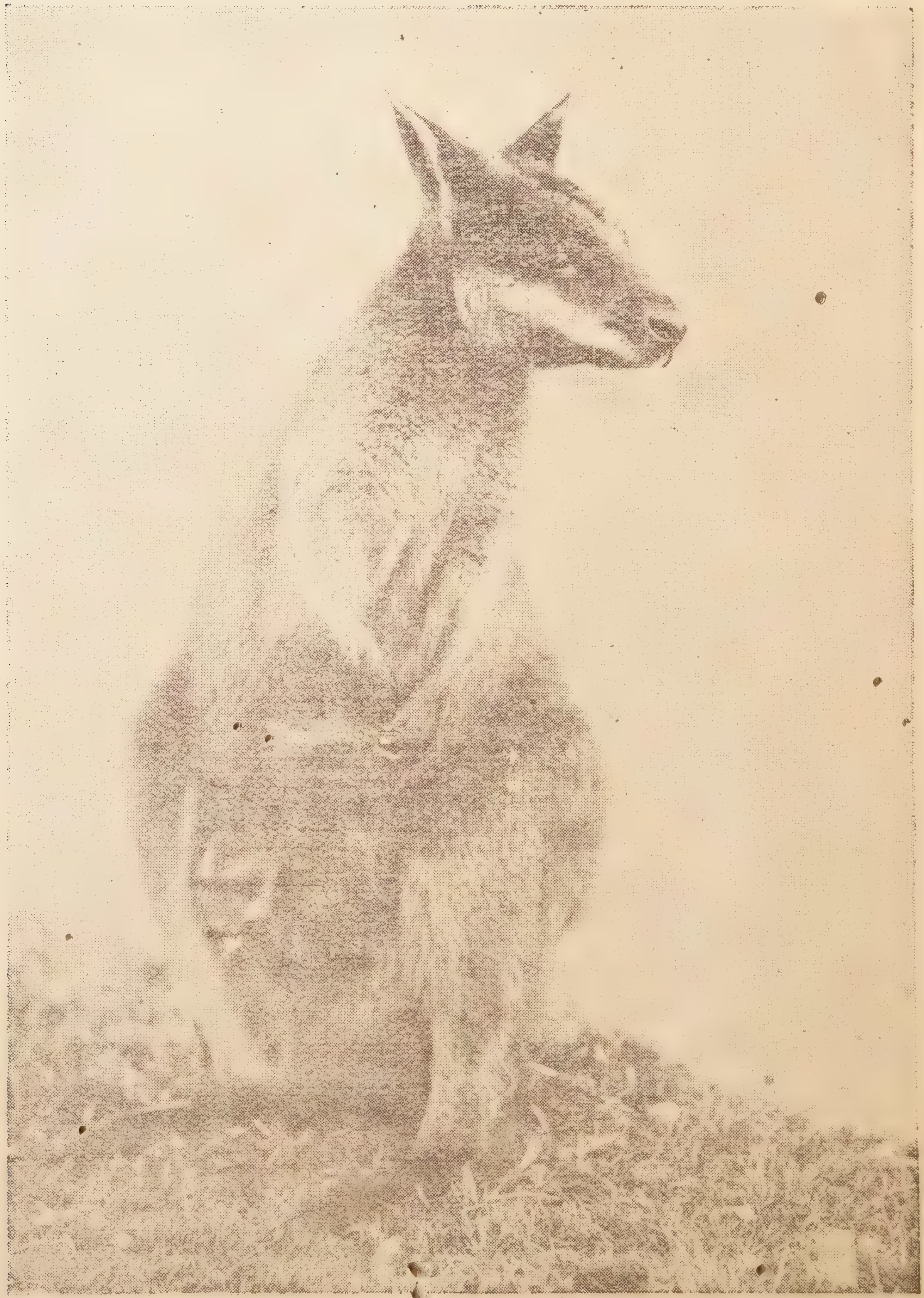


Fig. 97. A kangaroo carrying its young one in a pouch

Courtesy, Australian Government Photographs.

affection the cow feeds the calf, the cat suckles its kittens, carries them about from place to place, and how the dog feeds its several puppies. Some mammals carry

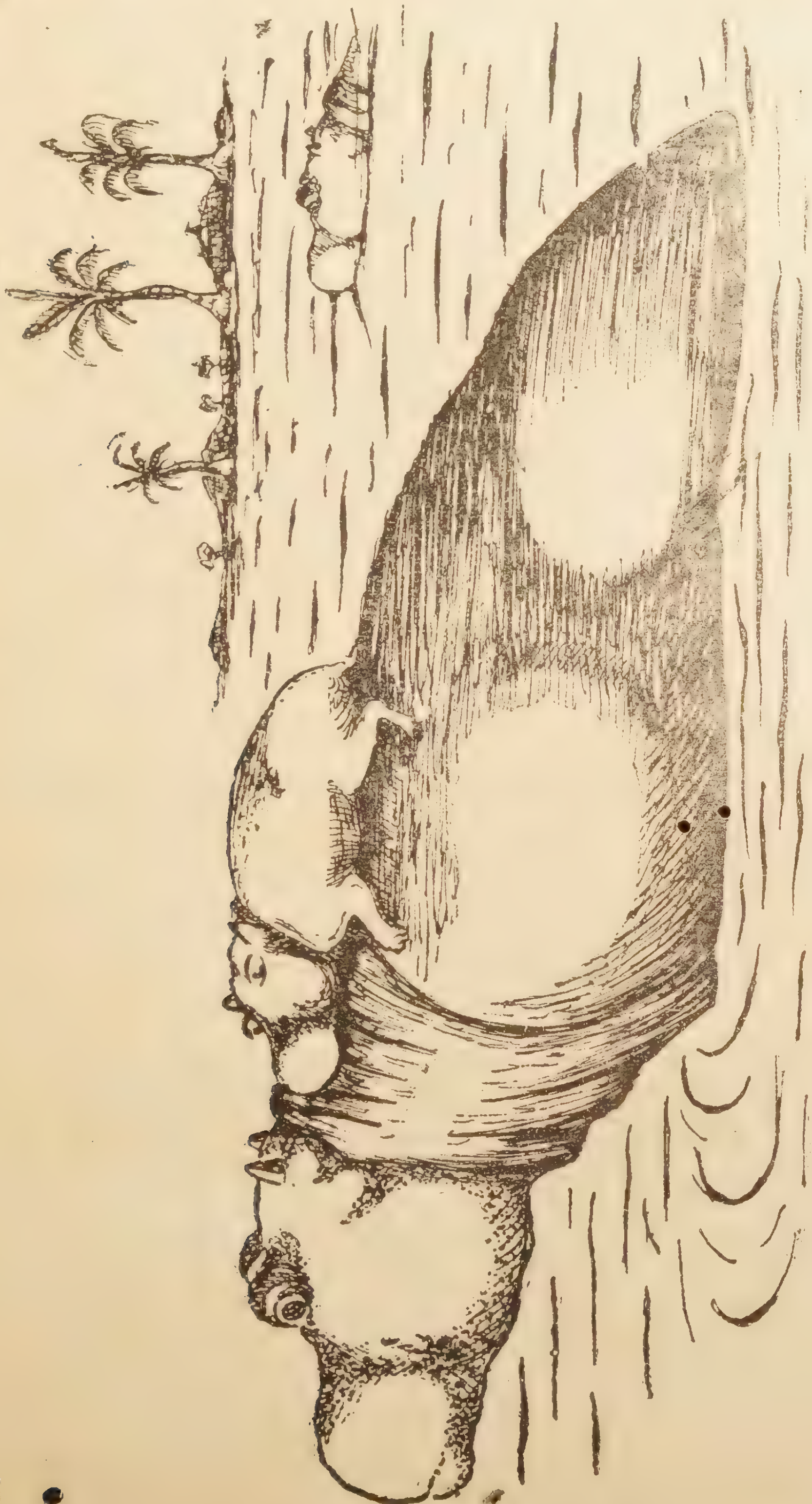


Fig 98. A Hippo carrying its baby.

their young ones clasped to their chests, like the bats and the monkeys. The kangaroo carries its young in a pouch. The Australian opposum carries the young ones all clustered on its back with their tails coiled round that of the mother. The huge hippopotamus carries her baby on her back.

Mammals show great affection towards their young ones. They will fight for them. The lion and the tiger have been known to give up their lives defending the young ones.

Elephants on the march, when pursued by hunters, always lead the young on the side less exposed to danger, well protected by their bodies.

CHAPTER XXIV.

ANIMAL SOCIETIES.

So far, we have studied animals as individuals. Animals of the same bodily organisation have the same requirements. This being so, it is advantageous some times for animals to live together, all working together towards a common object, the general welfare of the community. Here the needs of the individuals are given less importance to than those of the society as a whole. Such a society resembles primitive family associations of human beings. The members live together and the available food is divided equally amongst them and they face danger together. The same is true of animal societies.

A familiar example of an animal society is that of Bees living together in a honey comb. The picture of a portion of a honey comb is shown here. It is made up of wax which exudes from the underside of the abdomen and is worked by the hind legs of the bees. There are

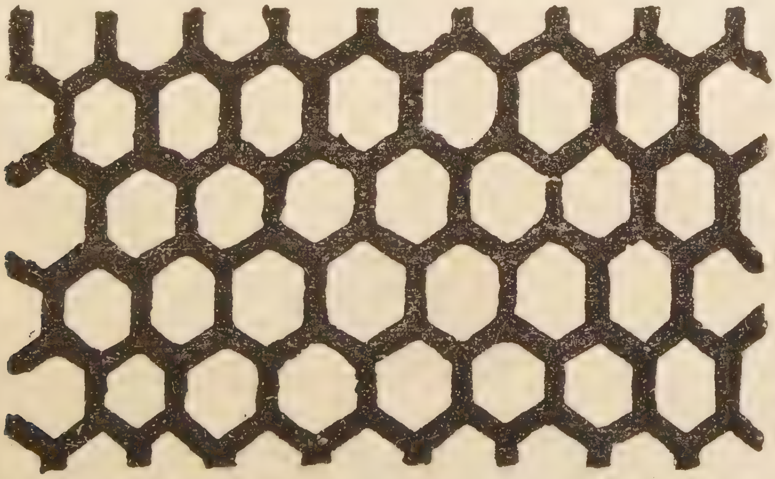


Fig. 99. Cells of a honey comb.

several chambers, all of six sides, known as *cells.* Several hundreds of bees live together. All of them are apparently alike. But there are certain differences according to their work. There are three kinds of individuals the *Worker*, the *Drone* and the *Queen.* They are shown in the picture. The worker is really a female bee which does not lay eggs. The drone is a male. The queen is a female which alone lays eggs in the whole society.

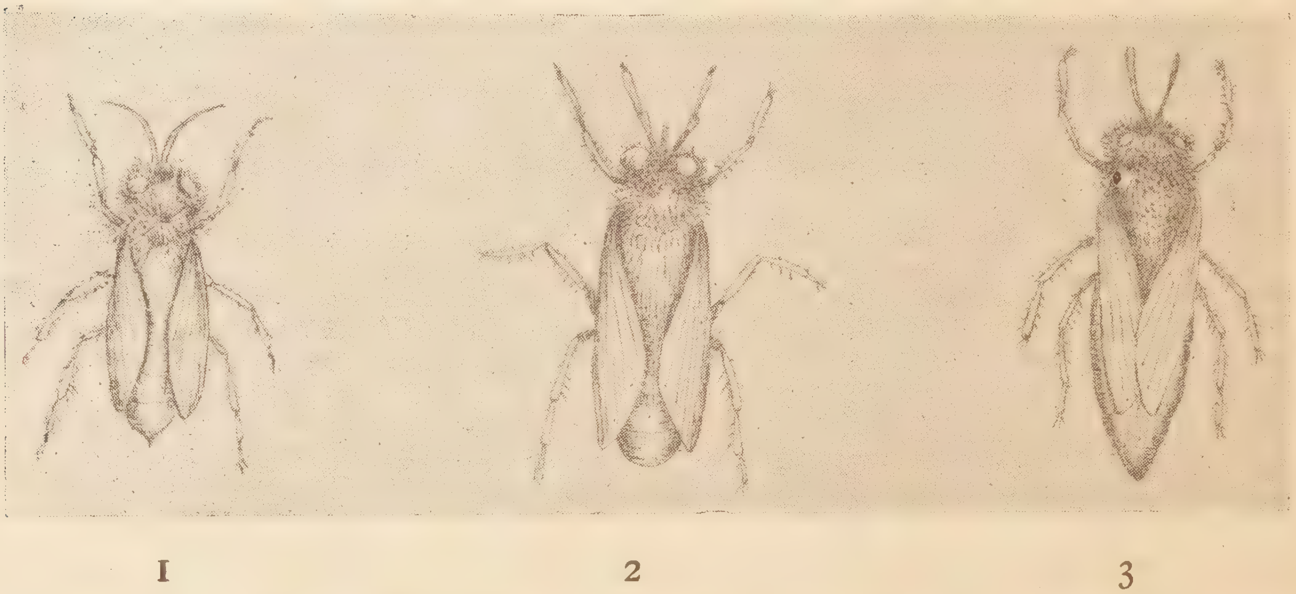


Fig. 100. Individuals of a bee community. I, drone; 2, worker; 3, queen.

In a hive, there are thousands of workers, a few drones, and usually a single queen. The business of the queen is to lay eggs. She occupies a cell called the *Royal chamber.* She is attended to by a number of workers who feed her and transfer the eggs to special chambers as the eggs are laid. Other workers go out in search of nectar and pollen. They bring the nectar home in their mouth where it becomes honey, vomit it, and store it. They feed the young ones, build the hive, guard and protect it, and do all the work of the hive. The honey is placed in several of the cells of the comb, ready to serve as food, for the growing larvæ and the queen.

The drones are lazy creatures. They are the males. They mate with the queen and enable her to produce eggs. When the eggs hatch out, most of them turn out to be workers. A few develop into queens and some into drones. The number in the hive has now increased. There is now more than one queen. It is a law in the Bee community that there ought to be only one queen in a comb. Therefore, the first queen either drives away the other queens or she herself goes away followed by a number of workers and a new home is founded. Here the queen lays more eggs, the workers tend them and these eggs hatch out into workers and a number of drones. If the founder of a new colony is young and unmated, she flies out and a drone mates with her. She then returns to her new home and begins her duty of egg laying. Perhaps, it is at this stage that the workers slaughter the drones. They are hereafter useless and their stay in the comb will only be a source of trouble and loss to the colony. The queen has already been mated. She can henceforth lay several thousands of eggs. There is no more work for the drones and they are mercilessly killed by the workers. This is known as the SLAUGHTER OF THE DRONES, *which is done in the interest of the whole community and not in the interest of any one member.*

The queen, due to the large number of eggs in her body, has a very large abdomen. The workers by the nature of the work they have to do, have their last pair of legs modified. They possess brush-like organs to collect the pollen and *pollen baskets* with which they can carry a large amount of pollen from flowers.

There is great discipline in a bee community. Each type of member has definite work allotted to it and they all work with great harmony. It is said that workers select a few female larvæ and feed them with a superior kind of food. This special treatment enables the fortunate larvæ to develop into queens. All other female larvæ develop into workers.

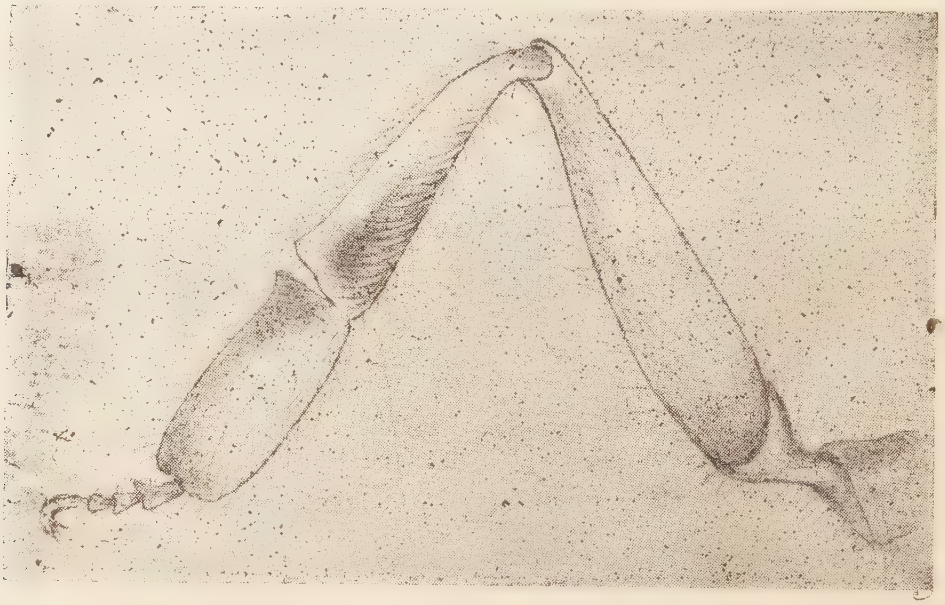


Fig. 101. Leg of a honey bee to show pollen basket.

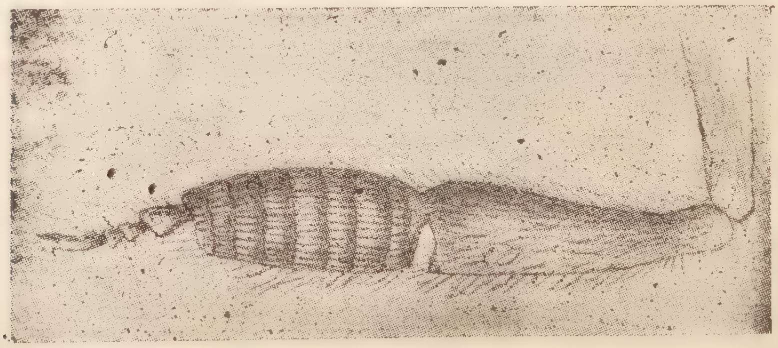


Fig. 102. Leg of a honey bee showing brush like organs.

There are other, equally well-developed, animal communities. The ant is an example. (Various kinds of ants live in some form of community). They work and live together and when danger threatens they fight together. The ant community commonly consists of winged *Males and Females*, wingless *Workers* and wingless *Soldiers*. The workers are deformed females which do not lay eggs. They do all the work of the community as in the case of the bees. The soldiers are workers with big heads and jaws. These are very strong and fight tenaceously. They have to defend the community against the attacks of other ants and other animals. They also have to lead the individuals of the community from one place to another for safety. Often they go out to fight with other ants and make slaves, bring them to their own community to do the work of the community. These are the slave making ants.

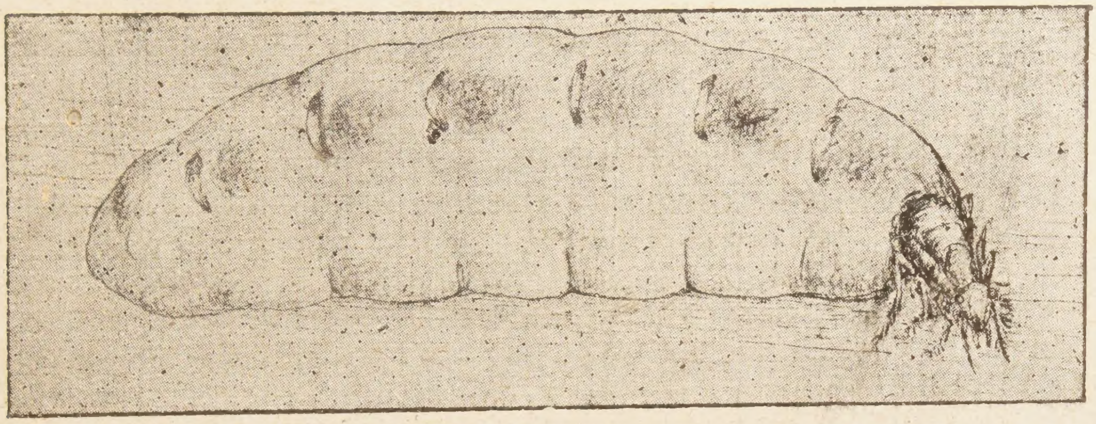


Fig. 103. A Queen ant.

Some ants keep 'cows.' The latter are plant lice. The common black ants keep such cattle. The workers attend to them, feed them and take care of them. They tap the abdomen of these insects from which a small drop of sweet juice comes out, which is known as the 'milk' of the Aphides. Ants are very fond of this. At certain times of the year the males and females come out and fly about. They mate at this time. After this flight the males die and the females lose their wings and come back to the ground and are led away by the workers either to the old nest or to found a new one.

Ants live on any kind of food, both vegetable and non-vegetable. Often they store up food in their nest. Their eggs are small and they develop into larvæ, which do not move, but are carried about by the workers and are fed by them from their mouth on semi-digested food. The pupal stage follows. The pupæ grow into wingless workers or soldiers or into winged males and females.

The nests of ants are not formed out of wax. They have no definite shape either. Many ants, like the common red ant, build their nests in trees. Others live under ground and construct galleries.

In social insects, there is division of labour amongst the members *and the welfare of the entire community is the sole object.*

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